HYDROCARBON EMISSIONS FROM APARTMENT BUILDING INCINERATORS

ARB-120-86-ETRD

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Ontario
Ministry of the Environment

The Honourable
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Minister

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HYDROCARBON EMISSIONS FROM APARTMENT BUILDING INCINERATORS

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1. EXECUTIVE SUMMARY

The performance of apartment building incinerators was studied at 11 incinerator sites in Toronto. The study focused on hydrocarbon emissions and combustion characterization. The chosen sites had a record of smoke and odour complaints.

The measurements were performed with a mobile testing laboratory and included continuous monitoring of exhaust gas temperature, oxygen, carbon dioxide, carbon monoxide and total hydrocarbons (THC). During the stack testing the incinerators were operated by the building superintendents according to normal practices. The test runs lasted at least a half hour following ignition.

During the first half hour of operation none of the units met the Ministry's THC emission limit of 100 ppm and only one did so after this period. THC concentrations from the 11 sites averaged 480 ppm as methane equivalent. Average combustion efficiency was poor (94.0 %) as a result of high excess air and low temperatures. Multichamber incinerators performed slightly better than flue fed units.

2. INTRODUCTION

The installation of incinerators in new buildings has been banned since 1967 in the City of Toronto (By Law 8967). Existing incinerators were allowed to operate and have been subject to frequent smoke and odour complaints. Allowable hydrocarbon concentration in incinerator flue gases is limited to 100 parts per million equivalent methane, as required by Section 12 of Regulation 308.

In July 1986 this testing program was carried out in Toronto to assess the performance of existing apartment incinerators and their compliance with the hydrocarbon standard. Testing was performed at 11 incinerator sites selected on the basis of complaints records. Central Region staff selected the incinerators, made pretest arrangements and acted as on site coordinator.

The tests were carried out by Air Resources staff using a mobile laboratory, Stationary Source Emission Monitoring Unit (SSEMU). The incinerators were operated by the building superindentents or designated operators. The tests lasted up to 2 hours and with few exceptions all the available garbage was burned in that time.

3. DESCRIPTION OF THE INCINERATORS TESTED

3.1 Flue-fed incinerators

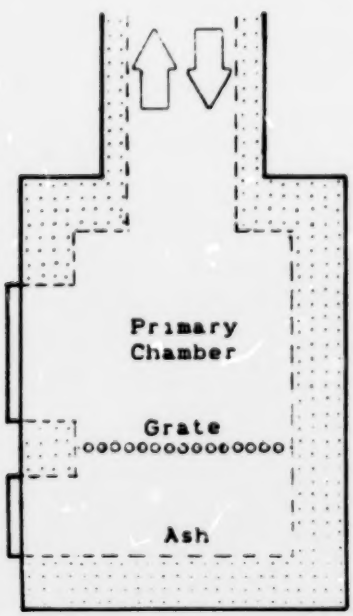
The simplest apartment incinerator is the flue-fed type, which is depicted in Figure 1. The equipment consist of two compartments separated by a fixed cast iron grate. The incinerator walls are made on site with refractory bricks. The upper chamber is where combustion takes place. The lower chamber serves to collect ash and to supply underfire air. The incinerator is located in the basement, at the bottom of a vertical duct which runs through the apartment building and is open above the building roof. The duct has chutes at each floor level to receive the garbage. It also serves to exhaust the products of combustion to the atmosphere.

The incinerator is operated typically once per day. The operator checks to ensure that enough garbage has accumulated and then he ignites it. The upper chamber door is kept closed during the burn. The lower chamber door is kept partially open. Initially combustion is intense but it gradually slows down after the dry paper and plastics are consumed. After about one hour the load has been converted into smoldering ash. Fresh loads of garbage may fall through the chutes during the burn or after its completion. This affects combustion and hampers the removal of ash (e.g. cans) before the next burn.

The testing program included only one unit of this type.

Figure 1

TYPICAL FLUE-FED INCINERATOR

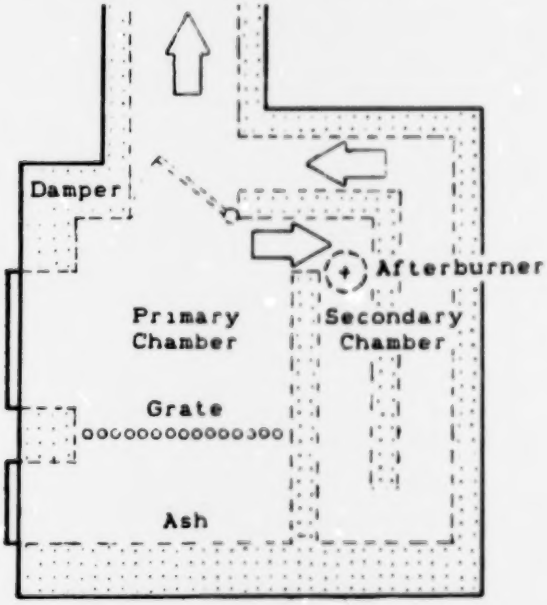


3.2 Modified Flue-fed Incinerator

Figure 2 depicts a modified flue-fed incinerator. The modifications consist of the addition of a secondary chamber, an afterburner and a set of dampers to a typical flue-fed incinerator. During the stand by periods, the dampers are opened and the garbage falls into the primary chamber, as in an ordinary flue-fed incinerator. Before the burn the dampers are closed and the combustion gases are forced to go through the afterburner flame and thorough the secondary chamber. Any garbage fed during the burn is held above the dampers until the completion of the burn, thus allowing the removal of ash and cleaning of the bottom grate.

Figure 2

MODIFIED FLUE-FED INCINERATOR



The testing program included two modified flue-fed incinerators. Both units, however, lacked a mechanism to lock the dampers in the closed position. It was observed that the momentum of the falling garbage was enough to open the dampers. In these cases the apparent advantages of the modified flue fed design was invalidated.

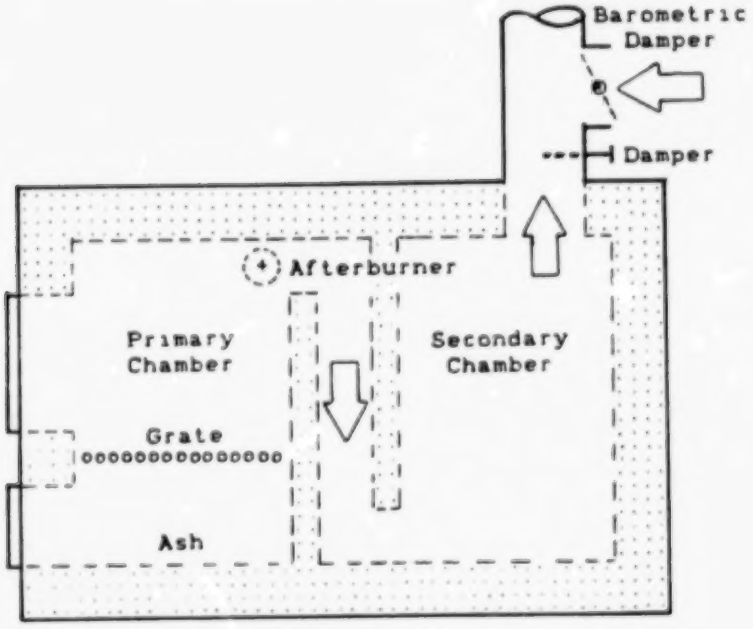
3.3 Multichamber Incinerators

Eight of the tested incinerators were of the multichamber type. Multichamber incinerators are composed of three independent chambers or zones, as depicted in Figure

3. Garbage is charged into a primary chamber, which represents about 15 % of the incinerator volume. The charge is lit manually or with an auxiliary burner. The secondary chamber is actually a labyrinth or a series of compartments where the exhaust gases are mixed and the high temperature maintained. The afterburner is installed between the primary and secondary chambers. The third independent chamber serves to collect ash beneath the primary chamber and to supply underfire air through the bottom grate.

Figure 3

MULTICHAMBER INCINERATOR



This type of garbage disposal system has separate ducts to collect the garbage and to vent the products of combustion. At the bottom of the feeding duct there is a bin or a room to store the refuse. The incinerator is located on the same basement floor and is fed intermittently by hand. Sometimes glass and cans are separated during feeding.

Multichamber incinerators are factory built and consist of a steel shell internally lined with refractory bricks. They are equipped with various doors and dampers. The largest door serves to feed the garbage and to remove the noncombustible residues (e.g. cans) at the completion of the burn. Beneath the primary and secondary chambers there are a

burn. Beneath the primary and secondary chambers there are a number of ash doors which also serve to control the supply of combustion air. Some units are equipped with additional overfire air inlets. The draft from the exhaust duct is controlled with a barometric damper which mixes ambient air with the exhaust gases. Often there is a second damper to throttle the incinerator exhaust.

The schematics of all 11 incinerators tested are included in Appendix A. A summary of all incinerator types and their characteristics is presented in Tables 1 to 3.

Table 1

TESTED SITES

Site No.	Address	Apartments Total	Incinerator Type	Test Time (min)
1	22 Thorncliffe	59	Multichamber	30
2	6 Mile Post	85	Multichamber	45
3	8 Mile Post	70	Multichamber	59
4	470 Mortimer	42	Flue fed	58
5	17 Lascelles	157	Modif. flue fed	47
6	25 Lascelles	250	Two modif. flue fed	60
7	35 Brookwell	76	Multichamber	120
8	130 Cosburn	48	Multichamber	60
9	39 Brookwell	56	Multichamber	90
10	230 Woolner	127	Multichamber	30
11	220 Woolner	127	Multichamber	30
TOTAL.....		1097		629

Table 2

INCINERATOR CHARACTERISTICS

Site No.	Incinerator type	Brand and rating	Prim. chamb. (m3)	Grate area (m2)	Afterburner fuel
1	Multichamber	-	0.9	0.7	oil *
2	Multichamber	-	1.2	1.1	oil *
3	Multichamber	-	0.9	1.1	oil *
4	Flue fed	-	0.8	1.0	-
5	Modif. flue fed	-	3.7	2.6	nat. gas
6	Modif. flue fed	-	2.2	1.3	nat. gas
7	Multichamber	Acorn,204 kg/hr	1.7	1.5	nat. gas
8	Multichamber	Neilson NR60	0.5	0.7	oil
9	Multichamber	Acorn,136 kg/hr	1.2	1.2	nat. gas
10	Multichamber	E. Dickey	1.5	1.7	oil
11	Multichamber	E. Dickey	1.5	1.7	oil
AVERAGE.....			1.5	1.3	

* afterburner was not operated

Table 3

AFTERBURNER CHARACTERISTICS

Site No.	Fuel type	Brand, model, rating
1	oil	Conroy Model J-JX 6300, 110 VAC 4.7 amp
2	oil	Metroheat Model D-13, 110 VAC 4.3 amp., 280,000 - 420,000 BTU/hr
3	oil	-
4	none	-
5	gas	Ray type 1G23 Size 2 (6 bunsen type burners)
6	gas	Ray type 1G23 Size 2 (6 bunsen type burners)
7	gas	Aero Environmental Model 2PGB-220, 65,000 - 220,000 BTU/hr
8	oil	Terry Model B, 1/8 HP fan 1725 rpm, estd. 1,400,000 BTU/hr
9	gas	Barber IBB 750, 120 VAC 0.5 amp fan 1650 rpm, 100,000 - 750,000 BTU/hr
10	oil	Aero Environmental, Model E, 420,000 to 840,000 BTU/hr.
11	oil	Aero Environmental, Model E, 420,000 to 840,000 BTU/hr.

4. SAMPLING METHODS AND EQUIPMENT

All sites were visited prior to the tests to assess sampling locations and parking spaces for the mobile laboratory. The three flue-fed incinerators were sampled from the first floor chute whereas that the other units were sampled at the incinerator exit, upstream of the barometric damper. In both cases the sample represented the undiluted incinerator exhaust gas.

The sampling system is depicted schematically in Figure 4. The sample probe was 1/8" dia. stainless steel tubing with a length varying from 0.3 to 0.6 m. The primary filter was a 2 cm x 4 cm glass-wool plug enclosed in a stainless steel shell. The sampling rate was about 4 litres per minute. Aproximately half of the sample was analyzed for total hydrocarbons (THC) and the other half for carbon dioxide (CO2), carbon monoxide (CO) and oxygen (O2). The THC sample was conveyed through a heated teflon line (160 deg C) whereas the other half was cooled in an ice bath and conveyed through a standard teflon line. The lines were either 60 m long or 120 m long depending on the layout of the different sites.

All the span gases were Matheson certified type. The THC fuel was hydrogen, Matheson lab quality. The zero gas was purified ambient air. The analyzers and reference gases used in the survey are listed in Table 4.

Table 4

ANALYZERS AND REFERENCE GASES

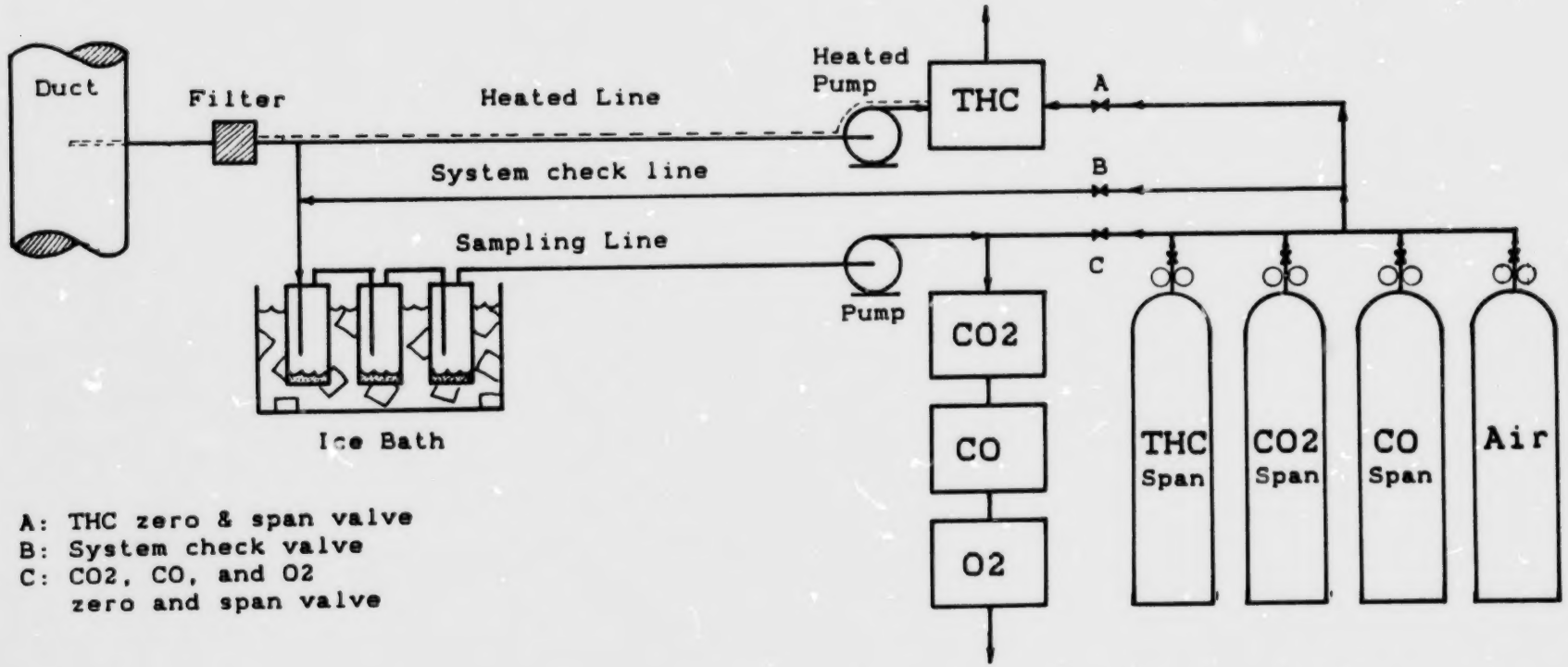
Specie	Analyzer	Type	Reference Gas
THC	Ratfisch RS5	FID	31.1 ppm C3H8 in N2
CO2	ADC	NDIR	11.9 % CO2 in N2
CO	Beckman 865	NDIR	1011 ppm CO in N2
O2	Beckman 755	Paramagnetic	purified ambient air

The analyzers, installed in a mobile laboratory - Stationary Source Emission Monitoring Unit (SSEMU) - were powered by an on board electric generator. The measurements from all analyzers were registered by a data acquisition system equipped with a CRT screen and a printer. The system polled all the analyzers every second, averaged the readings every minute and generated a summary report every half hour.

The analyzers were calibrated immediately before each test. Then the integrity of the sampling system was tested by injecting THC span gas at the front end of the two

FIGURE 4

SAMPLING SYSTEM SCHEMATIC



A: THC zero & span valve
B: System check valve
C: CO2, CO, and O2 zero and span valve

sampling lines. The system check was considered satisfactory when the THC analyzer measured +/- 5 % of the span value and the oxygen analyzer measured less than 0.1 % oxygen.

At the end of the test the THC analyzer was recalibrated and purified ambient air was injected at the front end of the sampling lines. About 4 minutes of air purge were typically required to obtain THC readings below 10 ppm, depending on the THC levels recorded during the test. The higher the THC measurements the longer it took to desorb the hydrocarbons from the inner surface of the sampling line. The hydrocarbons absorbed in the sampling line represent a relatively insignificant fraction of the levels registered during the tests (480 ppm average).

The exhaust gas temperature was measured with a J type thermocouple adjacent to the gas sample line. Temperature was read every minute from a digital display and recorded manually.

Whenever possible the amount of garbage fed into the multichamber incinerators was weighed with an electronic scale. Often the first full load served to visually estimate the weight of subsequent garbage loads. The weight of garbage incinerated in flue-fed units was not weighed, since the chamber was already filled.

5. RESULTS AND DISCUSSION

The duration of the test burns varied from site to site proportionally to the amounts of waste to be disposed of and the capacity of the incinerator. The duration of the tests ranged from half hour to two hours. The results from the initial half hour of testing at each site will be presented and discussed first. The corresponding raw data is included in Appendix B. The THC concentrations are reported as methane equivalent, on wet basis. The CO2, CO, and O2 concentrations are reported on dry basis.

During the first half hour, THC concentration from the 11 sites averaged 480 ppm and the site to site variation was from 214 ppm to 746 ppm. All the incinerators exceeded by a considerable margin the 100 ppm standard. The THC concentration peaked at about the time of maximum combustion rate, a few minutes after ignition, and then decreased slightly as combustion slowed down. However, various exceptions to this general pattern were observed. The time variation of THC, O2, CO2, CO and exhaust gas temperature for each site were plotted and are included in Appendix C.

All the measured parameters varied within a wide range during each test. Typically the lowest concentrations of THC, CO2 and CO were recorded at the begining of each test. The variation range of the measured parameters are summarized in Table 5.

Table 5

RANGE OF MEASUREMENTS
(first half hour)

Site No.	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	Temp. (C)
1	16.35-20.79	0.07-3.49	2-878	28.1-449.2	70-316
2	13.87-20.49	0.41-5.62	61-1620	32.2-1275.2	71-317
3	8.75-20.67	0.55-9.58	2-1621	20.3-911.0	108-460
4	14.15-18.96	1.21-5.46	498-3055	132-1274.2	91-175
5	15.11-20.81	0.05-5.82	18-2331	83.1-963.8	58-197
6	13.39-18.47	1.47-5.88	3-2239	49.7-1046.5	90-180
7	14.67-20.85	0.04-4.90	11-1028	106.5-831.9	69-365
8	13.40-20.75	1.79-5.73	80-3244	43.2-1263.6	169-351
9	14.75-20.42	1.82-4.48	97-1079	21.6-629.9	335-428
10	14.56-18.69	1.46-2.41	571-1388	68.3-1152.8	169-276
11	16.07-20.65	0.37-3.85	85-2767	119.9-1274.4	91-222
Overall	8.75-20.81	0.04-9.58	2-3244	20.3-1275.2	58-460
Average	17.34	2.63	982	480	216

Combustion was characterized by high excess air, low temperature and poor combustion efficiency. Oxygen, carbon dioxide and carbon monoxide concentrations averaged for all the incinerators tested 17.34 %, 2.63 % and 982 ppm, respectively. A combustion efficiency, defined here as the ratio of CO2 to (CO + THC + CO2), averaged 94.0 % and ranged from 88.7 % to 97.2 %. Solid residue was excluded from combustion efficiency calculation.

Combustion excess air varied from 284 % to 1,404 %. Hydrocarbon concentrations (adjusted to 12 % CO2) generally increased with higher excess air levels. The average THC concentration (adjusted to 12 % CO2) and the excess air levels for all sites are plotted in Figure 5.

The averages from all the first half hour measurements were summarized in Table 6.

Table 6

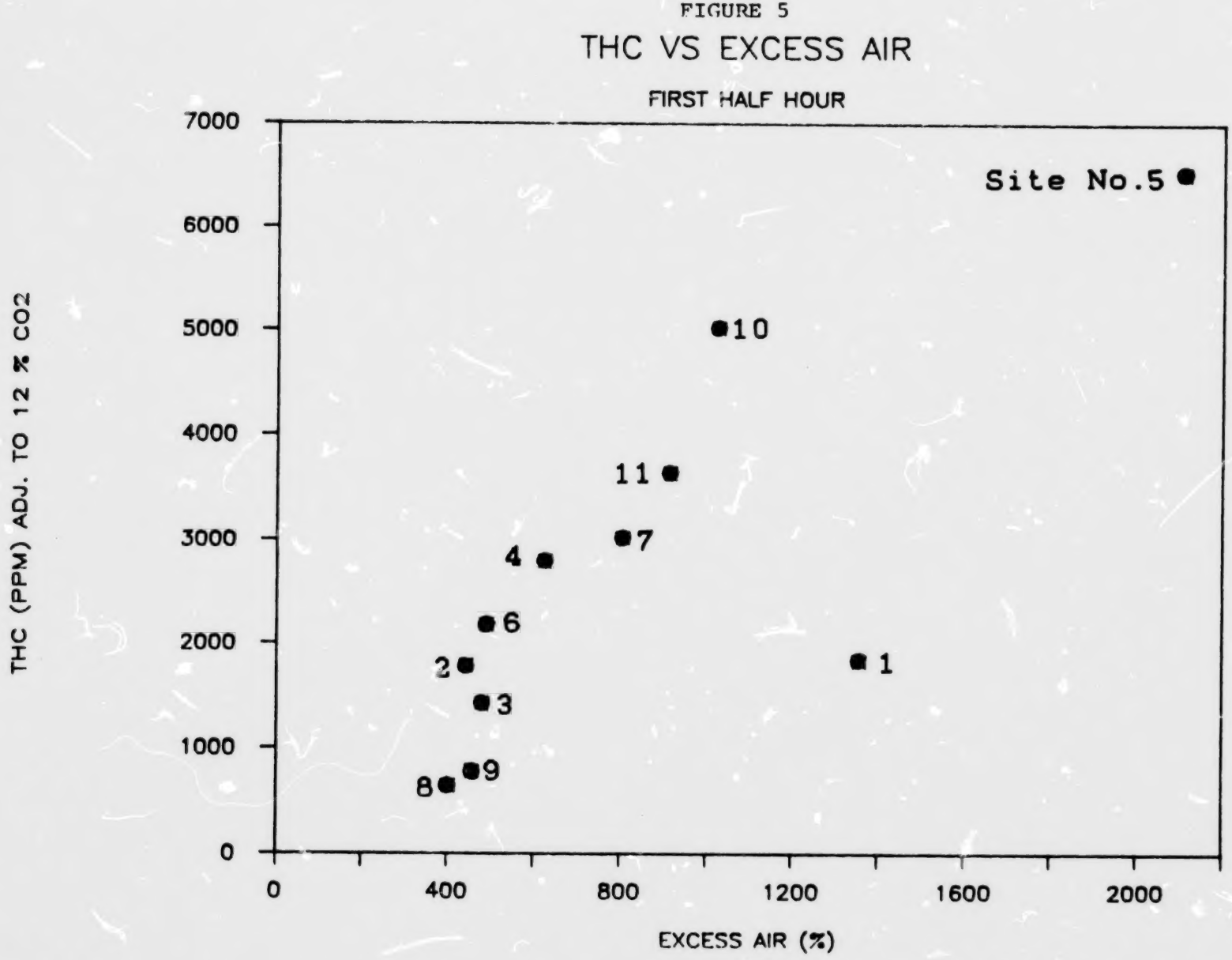
SUMMARY OF RESULTS
(first half hour averages)

Site No.	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	Temp. (C)	Feed (kg/hr)	Eff. (%)	Excess Air (%)
1	18.99	1.40	514	214	171	74	95.1	930
2	16.23	3.67	1200	549	243	100	95.4	329
3	16.81	3.50	962	417	264	155	96.2	396
4	17.15	2.75	1488	642	141	-	92.8	427
5	19.60	0.93	682	506	102	-	88.7	1404
6	16.22	3.31	1327	604	152	-	94.5	322
7	17.94	2.23	628	562	210	124	94.9	569
8	15.72	3.93	905	214	292	76	97.2	285
9	15.78	3.46	759	227	403	166	97.2	284
10	18.24	1.78	1023	746	246	155	91.0	631
11	18.10	1.98	1313	602	150	174	91.2	600
Ave.	**17.34**	**2.63**	**982**	**480**	**216**	**128**	**94.0**	**561**

Combustion eff.: $100 \times 10000\ CO_2 / (CO + THC + 10000\ CO_2)$

Excess air: $$\frac{\%O_2}{0.264 \times (100 - \%O_2 - \%CO_2) - \%O_2}$$

FIGURE 5


THC VS EXCESS AIR
FIRST HALF HOUR
Site No.5
THC (PPM) ADJ. TO 12 % CO2
EXCESS AIR (%)
7000
6000
5000
4000
3000
2000
1000
0
0
400
800
1200
1600
2000
10
11
7
4
6
2
1
3
9
8

A possible correlation between THC and CO concentrations was investigated. One minute averages for THC and CO were plotted, however, no apparent correlation was observed except that the concentrations of CO are generally higher than THC concentrations. The CO vs. THC plots were included in Appendix D.

The various first half hour measurements were lumped as per incinerator type to make relative comparisons. As a group the flue-fed incinerators had higher O2, CO and THC concentrations than multichamber units. The opposite applied to CO2, temperature and combustion efficiency. The THC concentration of flue-fed incinerators was 32 % higher than the multichamber type. In summary, the performance of flue-fed incinerators was generally poorer than all the others.

The performance of multichamber incinerators equipped with afterburners was compared with that of multichamber units whithout afterburners. The results are puzzling and unexpected. The afterburner equipped units averaged THC concentrations 20 % higher than those without. This finding does not imply that the afterburners were not beneficial, rather that they were probably too small or inefficient to make a significant reduction of emissions. This conclusion is supported by the rather similar O2, CO2 and temperature levels of the two groups of incinerators. A summary of results by incinerator type is listed in Table 7.

Table 7

RESULTS BY INCINERATOR TYPE
(first half hour averages)

Incinerator type	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	T (C)	Eff. (%)
Flue-fed (sites 4,5,& 6)	17.65	2.33	1166	584	132	91.2
Multichamber (sites 1-3, 7-11)	17.22	2.74	913	441	247	94.6
Afterburner off (sites 1-3)	17.34	2.86	892	393	226	95.4
Afterburner on (sites 7-11)	17.16	2.68	926	470	260	93.9
OVERALL (sites 1 to 11)	17.34	2.63	982	480	216	92.6

Seven incinerators were tested for more than one half hour. The extra testing periods totalled 299 minutes compared to 330 minutes of the combined initial half hour periods. Typically, the extra testing period included a second loading of the incinerator . The operating conditions were similar to the preceeding period.

The THC concentrations generally decreased after the first half hour. The time weighted average was 28 % lower than the initial half hour average for the same incinerator. One unit marginally complied with the THC standard during the second half hour of operation. This Neilson NR60 unit was also the best performer during the initial half hour. The incinerator had a small primary chamber (0.5 m3) and a large 1,400,000 BTU/hr oil afterburner.

The measurements of the periods subsequent to the first half hour are summarized in Table 8.

Table 8

COMPARISON OF INITIAL HALF HOUR AVERAGES
WITH SUBSEQUENT AVERAGES

Site, Ave. period	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	Temp (C)
2, first half hour	16.23	3.67	1200	549	243
, extra 15 min.	17.71	2.28	1230	303	219
3, first half hour	16.81	3.50	962	417	264
, extra 29 min.	15.76	3.99	1226	608	331
4, first half hour	17.15	2.75	1488	642	141
, extra 28 min.	19.63	1.55	905	550	98
5, first half hour	19.60	0.93	682	506	102
, extra 17 min.	20.63	0.08	276	451	58
6, first half hour	16.22	3.31	1327	604	152
, extra 30 min.	17.78	2.19	1058	530	164
7, first half hour	17.94	2.23	628	562	210
, extra 90 min.	18.39	1.77	878	329	259
8, first half hour	15.72	3.93	905	214	292
, extra 30 min.	16.19	3.33	265	90	338
9, first half hour	15.78	3.46	759	227	403
, extra 60 min.	16.82	2.44	568	165	423
2-9, Average of first half hour	17.34	2.63	982	480	216
2-9, Weighed Ave. of extra minutes	16.92 (-2 %)	2.23 (- 15 %)	792 (- 19 %)	346 (- 28 %)	269 (+25 %)

6. CONCLUSIONS AND RECOMMENDATIONS

a) Hydrocarbon emissions were measured at 11 apartment incinerators in Toronto. These units had a record of smoke and odour complaints. During the tests the incinerators were operated in a regular manner by the building superintendent or a designated operator. No unit was able to comply with Section 12 of Regulation 308 (100 ppm THC limit)

b) The THC concentrations from the most efficient incinerator averaged 214 ppm during the first hour of operation, as compared to the 480 ppm average of the 11 units combined. This incinerator had a large oil afterburner and operated with less excess air than the other units.

c) Emissions from flue fed incinerators had higher levels of THC and CO than the multichamber units.

d) Combustion was generally poor (94.0 % ave. efficiency) and the exhaust temperatures averaged 216 degrees Celsius. Excess air averaged approximately 561 %.

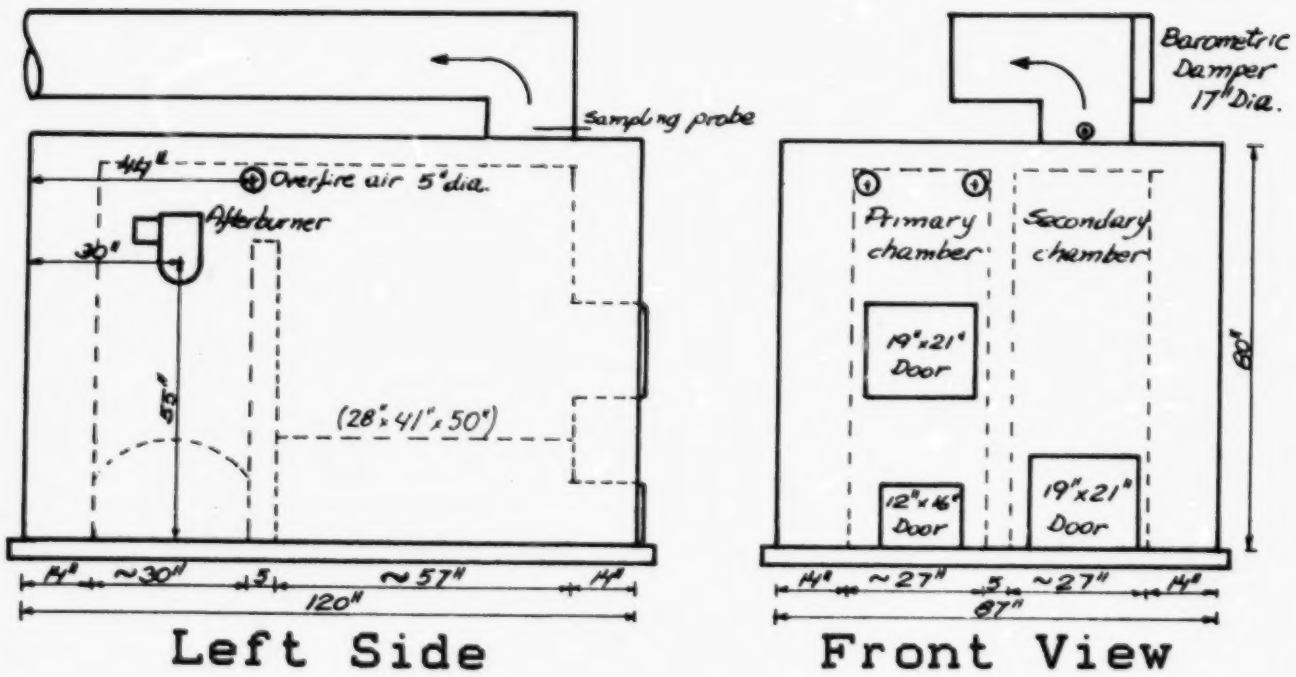
e) THC concentrations generally decreased after the first half hour of operation. The most efficient incinerator complied marginally with the 100 ppm THC limit after the first half hour of operation.

f) The speciation of the hydrocarbons emissions (including trace organics) and the measurement of particulate matter, are recommended.

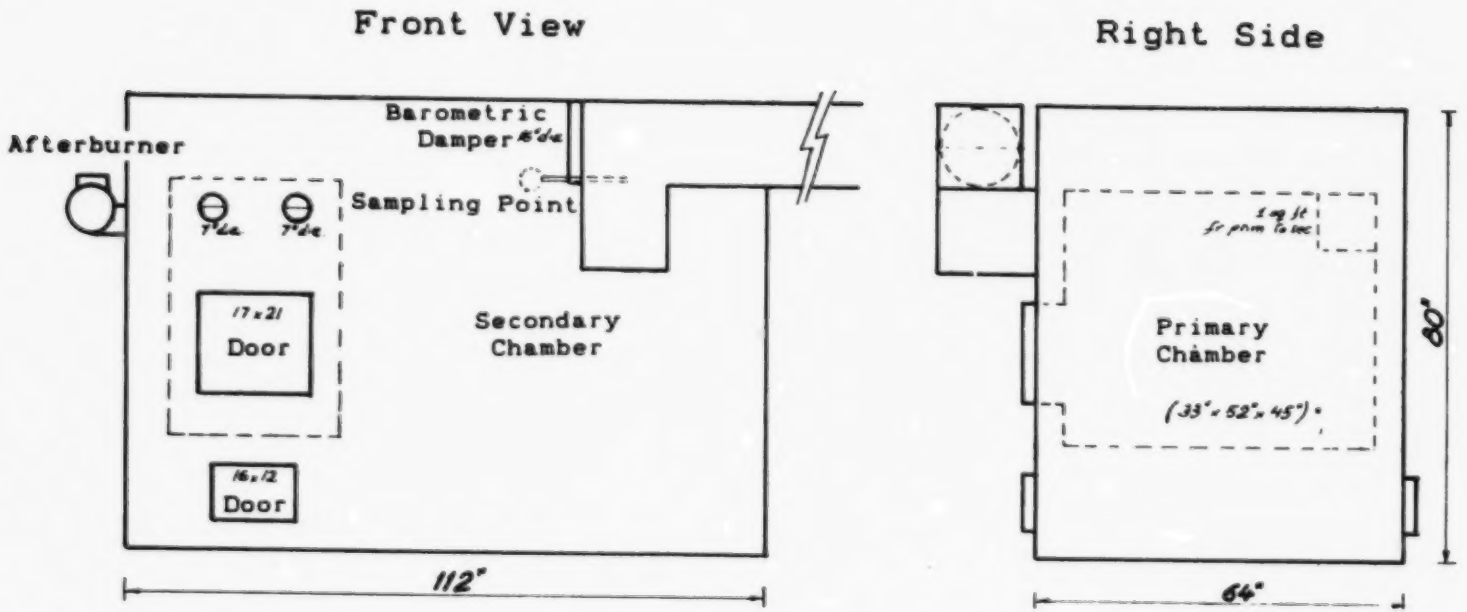
Appendix A

INCINERATOR SCHEMATICS

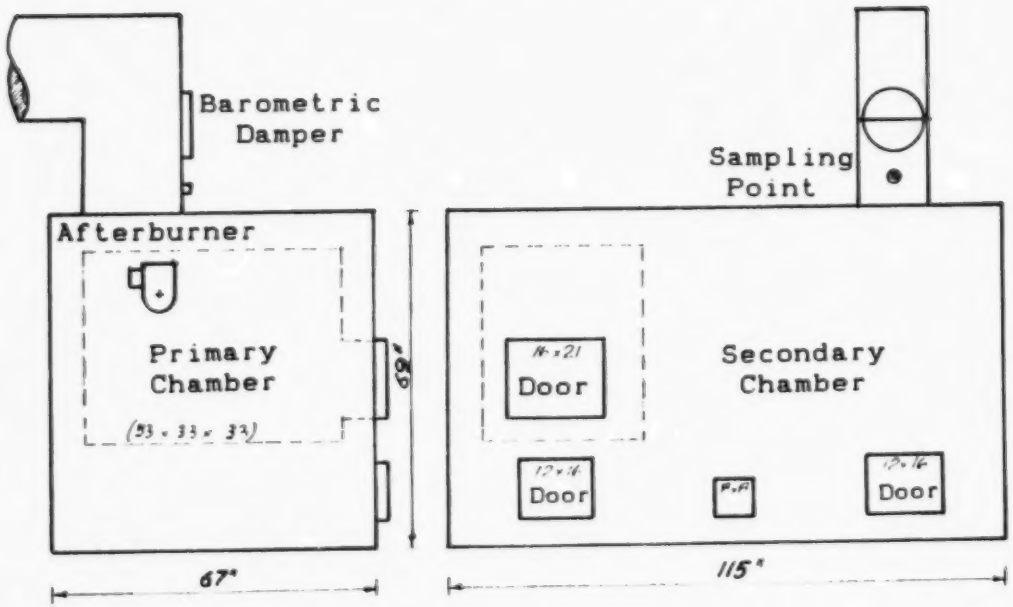
22 Thorncliff, Toronto
Incinerator Schematic



6 Mile Post , Toronto
Incinerator Schematic



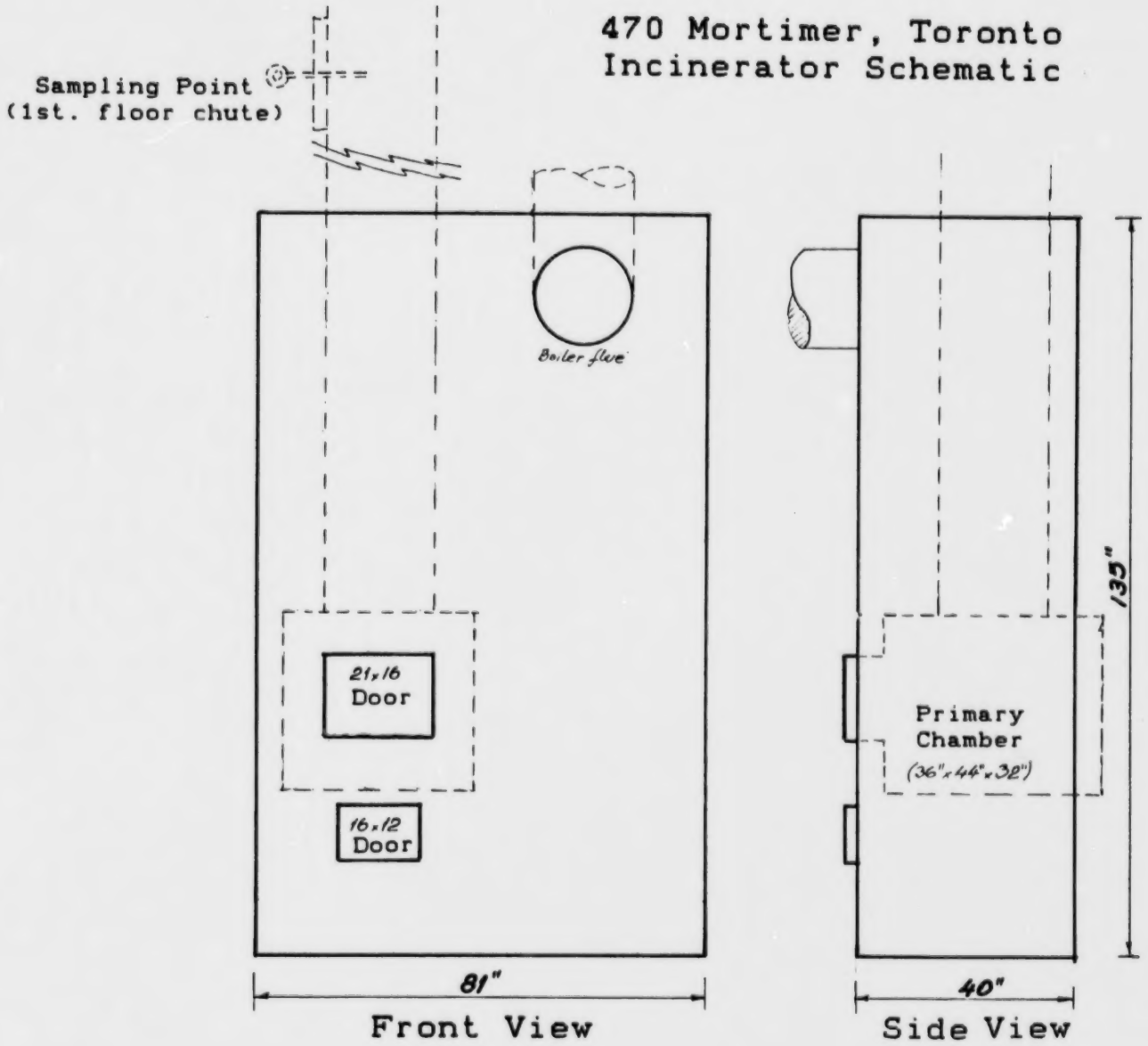
8 Mile Post, Toronto
Incinerator Schematic



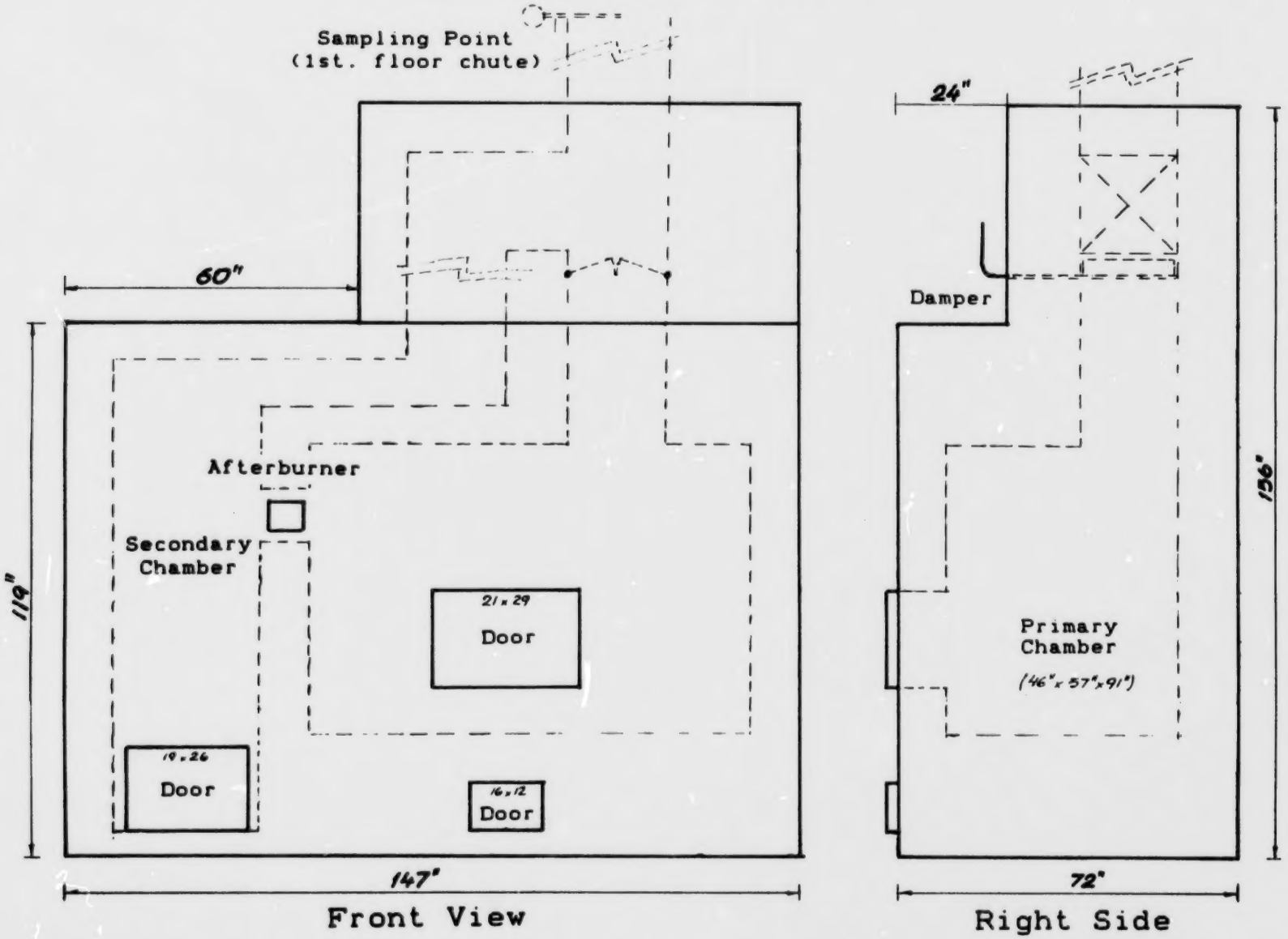
Left Side

Front View

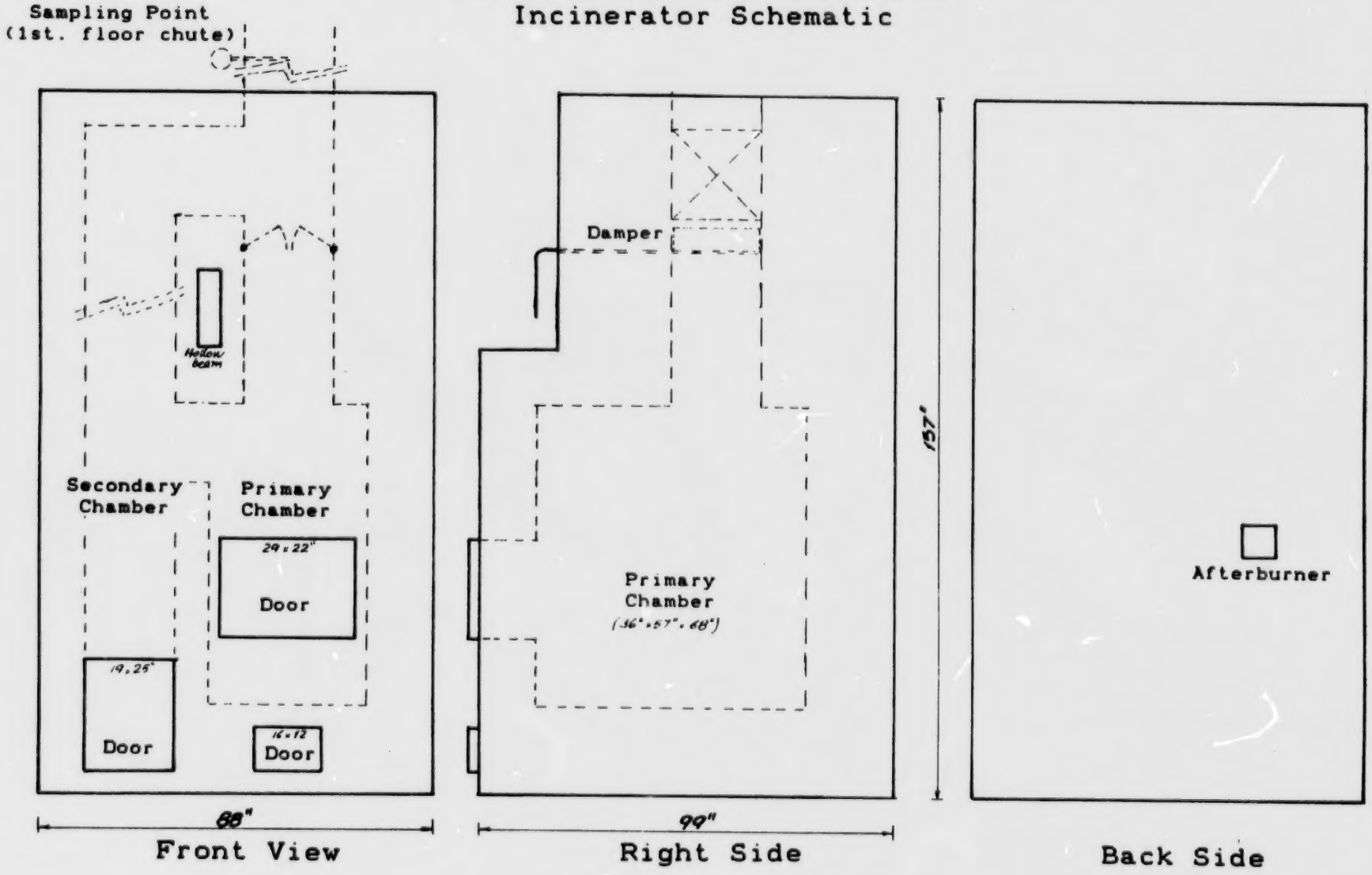
470 Mortimer, Toronto
Incinerator Schematic



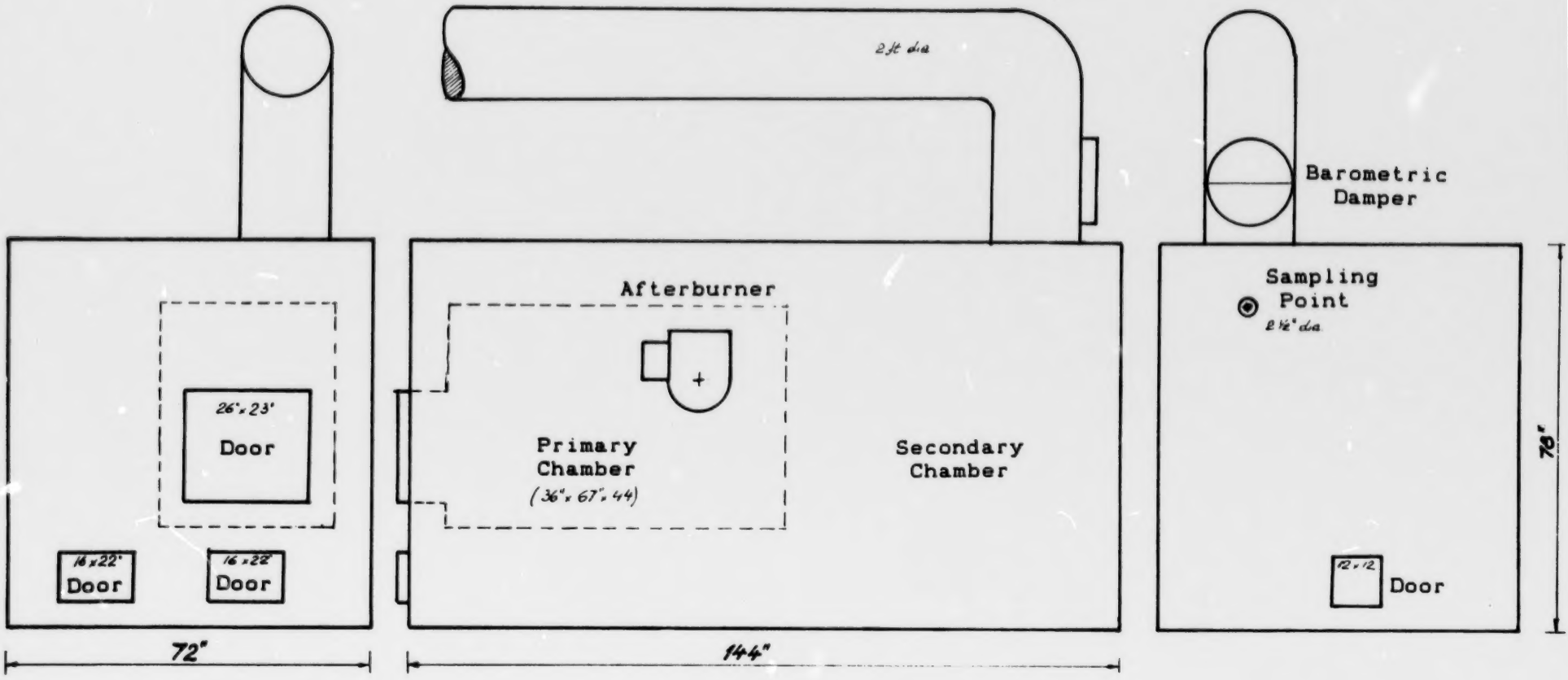
17 Lascelles Blvd., Toronto
Incinerator Schematic



25 Lascelles Blvd., Toronto
Incinerator Schematic



35 Brookwell Dr , Toronto
Incinerator Schematic

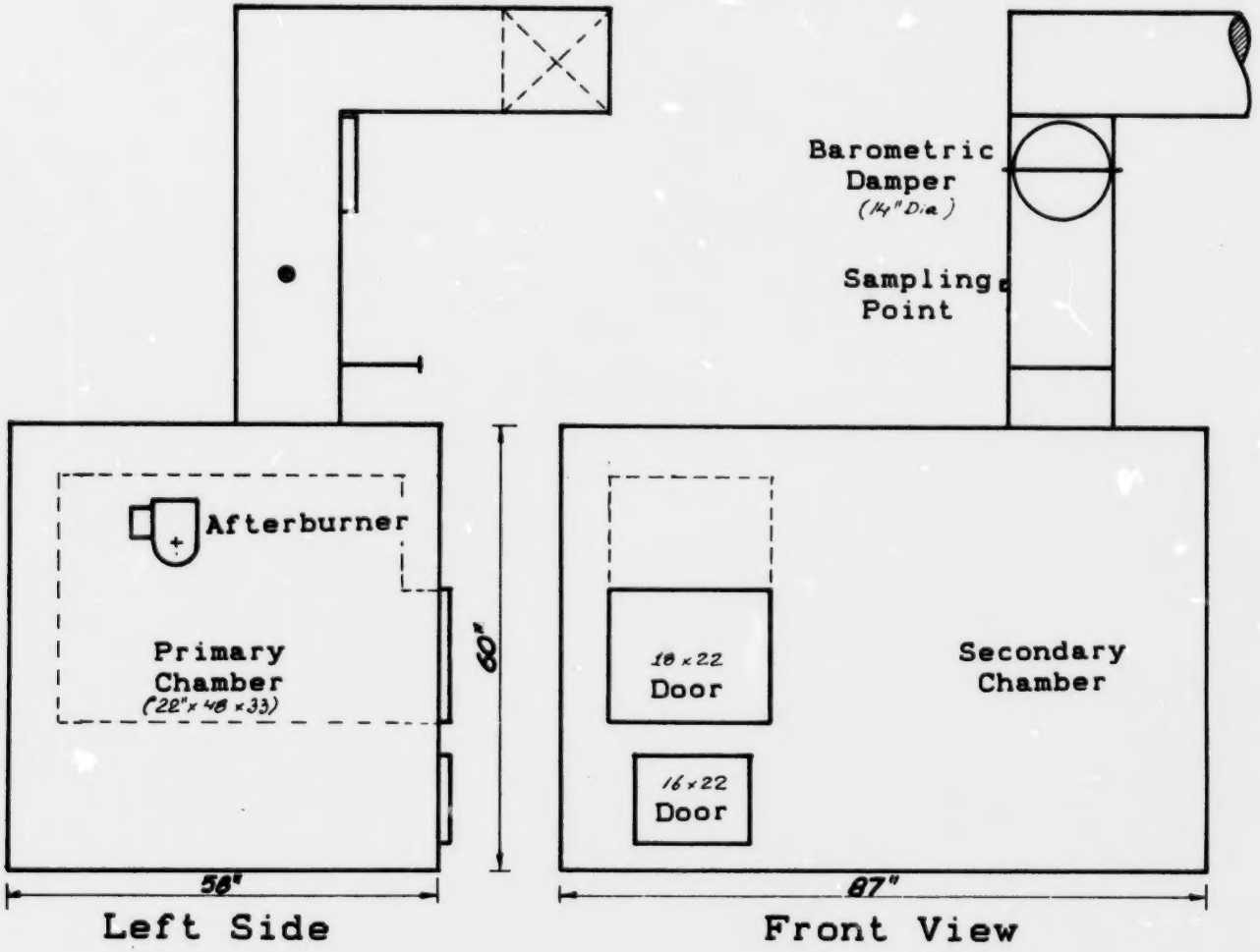


Front View

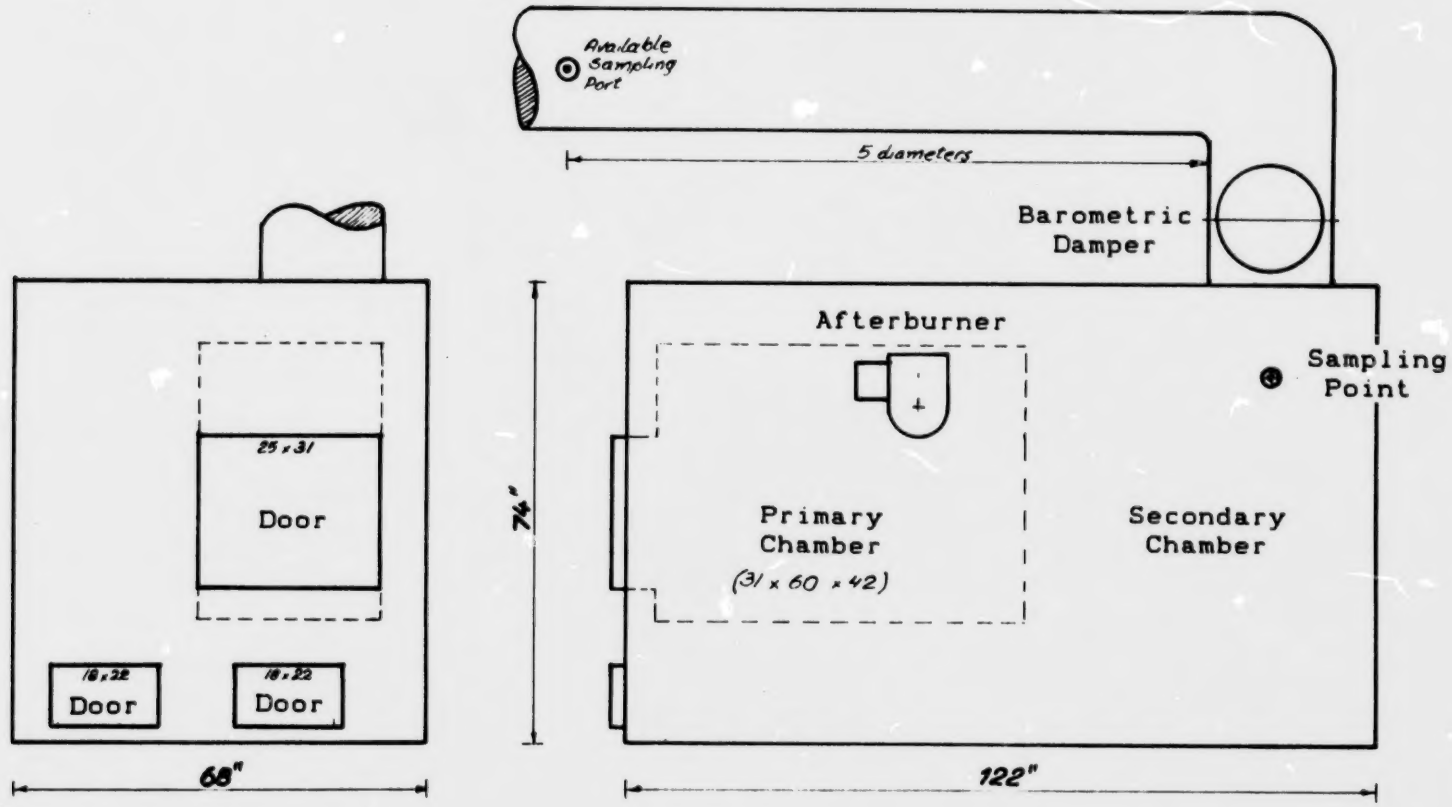
Right Side

Back Side

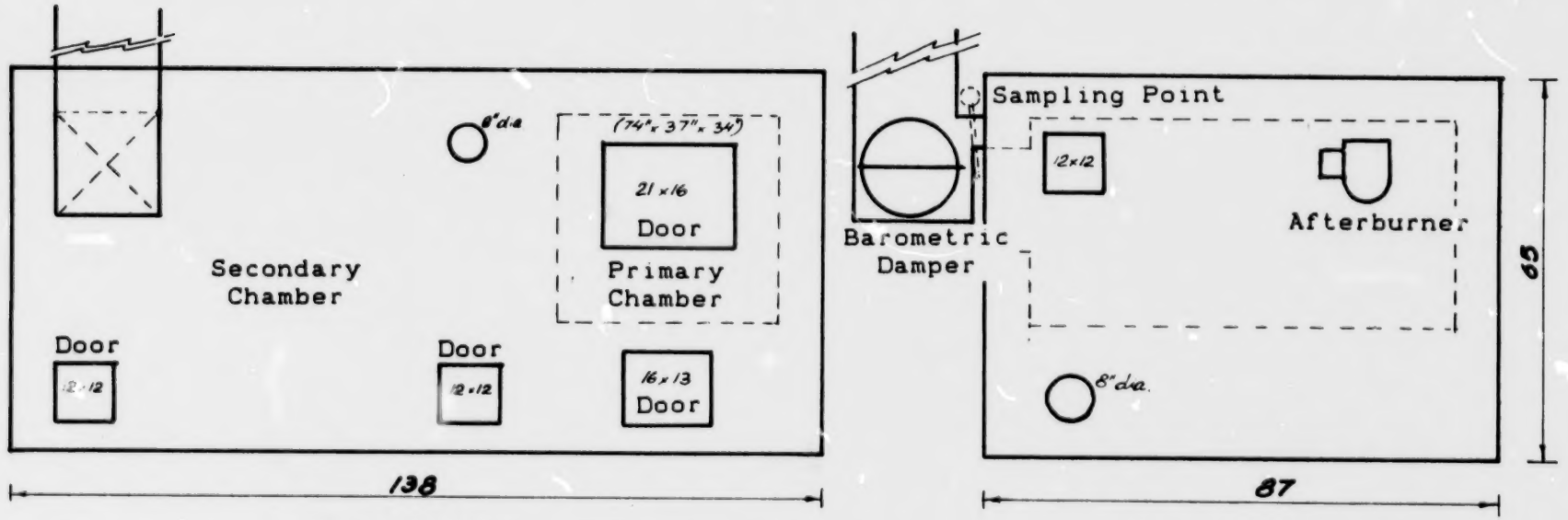
130 Cosburn, Toronto
Incinerator Schematic



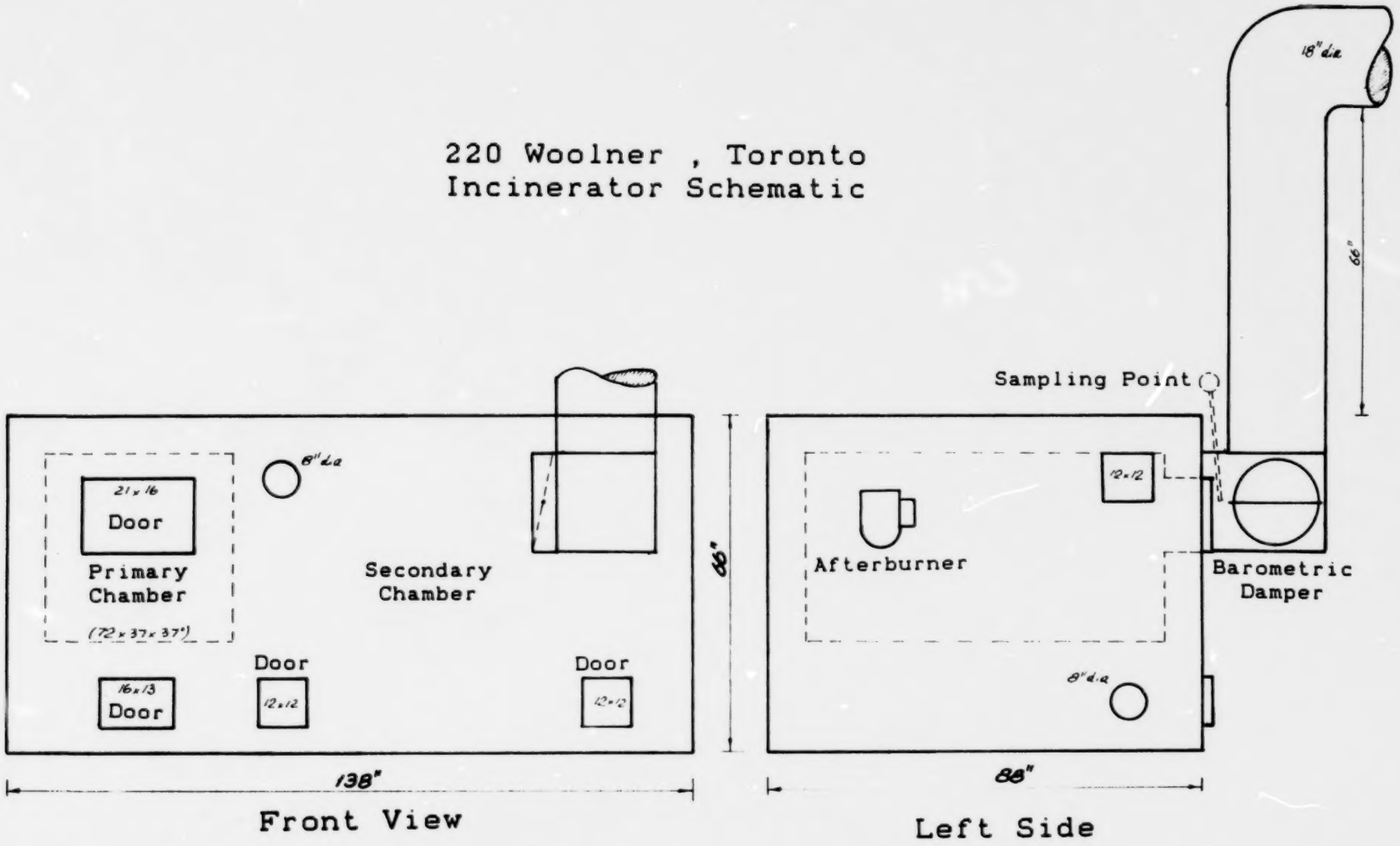
39 Brookwell, Toronto
Incinerator Schematic



230 Woolner , Toronto
Incinerator Schematic



220 Woolner , Toronto
Incinerator Schematic



Appendix B

TEST DATA
First Half Hour

TEST DATA

LOCATION: 22 Thorncliff Park, Toronto
SOURCE: Garbage Incinerator
DATE: 3 July 1986
START TIME: 7:24 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	20.79	0.07	2	28.1	70	23.3 kg of garbage was
2	20.61	0.40	29	94.4	133	fed in the first 4 min
3	19.75	1.60	163	108.7	215	
4	18.48	2.76	229	103.0	287	
5	17.00	3.43	377	113.0	316	
6	16.35	3.49	363	93.6	294	
7	16.65	2.83	333	86.1	256	
8	17.38	2.21	451	154.5	225	
9	18.17	1.81	564	196.1	194	
10	18.68	1.41	652	246.3	158	
11	19.20	1.03	778	318.1	130	
12	19.63	0.71	878	423.2	109	
13	19.93	0.57	815	449.2	100	
14	20.02	0.46	764	431.9	90	
15	20.07	0.35	683	396.6	78	additional 13.8 kg was
16	20.29	0.25	614	377.6	120	fed in 2 minutes
17	20.07	1.18	596	370.5	163	
18	19.19	1.38	513	355.0	232	
19	18.57	2.33	428	334.9	280	
20	17.60	2.60	331	319.6	229	
21	17.61	1.91	314	254.0	187	
22	18.42	1.48	429	218.0	173	
23	18.93	1.31	483	194.0	158	
24	19.18	1.12	533	173.1	150	
25	19.35	1.04	578	155.4	146	
26	19.41	0.98	616	144.5	143	
27	19.45	0.95	614	52.2	135	
28	19.53	0.87	680	74.7	124	
29	19.66	0.74	762	82.2	115	
30	19.79	0.62	849	81.9	110	
Ave.	18.99	1.40	514	214.3	171	Ave. Feed: 74.2 kg/hr
High	20.79	3.49	878	449.2	316	
Low	16.35	0.07	2	28.1	70	

TEST DATA

LOCATION: 6 Mile Post, Toronto
SOURCE: Garbage Incinerator
DATE: 7 July 1986
START TIME: 12:05 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	20.49	0.41	61	32.2	71	101.3 kg of garbage was
2	19.05	2.51	1199	37.5	125	previously loaded
3	16.88	2.69	1563	40.2	136	
4	17.71	1.88	941	84.9	140	afterburner used only
5	18.20	1.78	841	601.2	151	to ignite garbage
6	18.20	1.94	1096	586.7	170	
7	18.03	2.05	1203	465.1	164	
8	17.77	2.19	1394	353.6	136	
9	17.84	1.98	1536	397.7	140	
10	18.29	1.69	1503	575.4	155	
11	18.48	1.78	1508	650.6	237	
12	17.95	3.07	1613	618.8	271	
13	16.01	5.07	1555	685.1	296	
14	14.16	5.62	1620	812.6	293	
15	13.87	5.33	1619	948.1	293	
16	14.13	5.17	1568	1041.3	295	
17	14.20	5.26	1579	1204.3	303	
18	14.02	5.39	1620	647.2	304	
19	14.14	5.04	1456	754.9	299	
20	14.64	4.67	1184	1275.2	302	
21	15.03	4.49	968	814.3	302	
22	15.26	4.34	990	630.5	306	
23	15.41	4.19	1045	561.6	316	
24	15.63	4.27	886	481.7	313	
25	15.38	4.89	827	503.9	317	
26	14.89	5.06	680	467.1	308	
27	14.83	4.84	704	350.4	300	
28	15.10	4.55	922	300.5	290	
29	15.43	4.13	1071	293.2	280	
30	15.81	3.86	1245	258.6	273	
Ave.	16.23	3.67	1200	549.1	243	Estd. Feed: 100 kg/hr
High	20.49	5.62	1620	1275.2	317	
Low	13.87	0.41	61	32.2	71	

TEST DATA

LOCATION: 8 Mile Post, Toronto
SOURCE: Garbage Incinerator
DATE: 7 July 1986
START TIME: 2:43 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (C)	Observations
1	20.67	1.79	2	20.3	108	approximately 40 kg of
2	20.60	0.55	20	26.1	354	garbage was previously
3	19.39	3.11	249	53.0	394	loaded
4	14.42	8.83	1489	63.3	460	
5	9.47	9.58	1621	72.5	435	
6	8.75	9.56	1621	124.1	342	
7	10.70	7.16	1024	151.7	294	
8	13.90	4.68	383	911.0	265	
9	15.89	3.51	738	410.0	247	
10	16.95	2.74	1207	186.4	222	
11	17.55	2.37	1460	327.1	206	
12	18.09	2.02	1450	473.9	190	
13	18.43	1.81	1418	581.2	180	
14	18.73	1.60	1428	589.3	170	
15	18.93	1.52	1373	663.8	163	
16	19.05	1.40	1316	669.2	157	
17	19.27	1.24	1250	673.7	235	additional 61.0 kg was
18	19.21	1.25	1386	628.3	204	fed in 7 minutes
19	18.44	2.83	1245	720.5	182	
20	17.75	1.91	663	754.4	186	
21	18.48	1.92	784	344.5	156	
22	18.38	1.67	644	433.1	150	
23	19.10	1.19	684	347.8	230	
24	19.30	1.49	735	192.3	328	
25	18.35	3.29	687	468.1	340	
26	16.09	4.46	683	509.0	350	
27	15.22	5.88	1201	608.6	346	
28	13.88	5.79	751	566.7	350	
29	14.45	5.03	647	513.3	346	
30	14.92	4.94	717	425.9	343	
Ave.	16.81	3.50	962	417.0	264	Ave. Feed: 155.0 kg/hr
High	20.67	9.58	1621	911.0	460	
Low	8.75	0.55	2	20.3	108	

TEST DATA

LOCATION: 470 Mortimer, Toronto
SOURCE: Garbage Incinerator
DATE: 8 July 1986
START TIME: 11:50 a.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	17.67	2.71	498	132.5	91	
2	16.96	2.88	798	300.9	119	
3	16.82	3.56	1386	271.2	138	
4	16.09	3.52	2327	420.7	149	
5	15.92	4.48	2990	680.6	148	
6	15.03	5.46	3055	1244.9	147	
7	14.15	5.03	2197	1274.2	145	
8	15.12	3.84	2378	1123.0	162	
9	15.99	3.58	2435	873.9	175	
10	16.00	3.82	1821	742.7	168	
11	16.01	3.58	1806	899.4	162	
12	16.44	2.97	1689	684.4	163	
13	16.94	2.57	1351	625.1	159	
14	17.50	2.37	1465	617.6	154	
15	17.46	2.64	1503	590.4	150	
16	17.08	3.13	984	656.3	142	
17	16.54	3.17	914	688.9	138	
18	16.89	2.63	1003	557.7	142	
19	17.36	2.45	836	468.2	152	
20	17.45	2.32	936	475.1	149	
21	17.78	2.08	1112	469.2	146	
22	18.09	1.87	1128	469.4	143	
23	18.29	1.77	1293	538.8	138	
24	18.43	1.65	1454	593.5	128	
25	18.52	1.59	1244	624.2	123	
26	18.58	1.54	1232	651.5	124	
27	18.69	1.40	1310	682.5	123	
28	18.80	1.34	1117	666.1	120	
29	18.89	1.28	1252	615.7	120	
30	18.96	1.21	1128	613.0	118	
Ave.	17.15	2.75	1488	641.7	141	
High	18.96	5.46	3055	1274.2	175	
Low	14.15	1.21	498	132.5	91	

TEST DATA

LOCATION: 17 Lascelles Blvd, Toronto
SOURCE: Garbage Incinerator
DATE: 9 July 1986
START TIME: 11:14 a.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	20.81	0.17	18	83.1	98	
2	20.14	2.37	1010	590.9	145	
3	15.16	5.82	2331	963.8	192	
4	15.11	3.96	1079	368.5	197	
5	16.40	2.67	935	243.0	184	
6	17.62	2.02	1059	363.3	167	
7	18.43	1.58	1049	499.4	155	
8	18.86	1.27	1009	554.0	140	
9	19.19	1.06	906	671.0	130	
10	19.42	0.93	810	650.2	122	
11	19.62	0.74	742	607.9	112	
12	19.78	0.69	683	574.7	106	
13	19.86	0.60	605	533.8	102	
14	20.09	0.43	605	518.2	94	
15	20.20	0.36	601	517.1	86	
16	20.31	0.27	594	556.5	82	
17	20.45	0.15	522	557.2	76	
18	20.53	0.17	428	539.3	75	
19	20.49	0.23	388	552.8	75	
20	20.43	0.28	414	511.4	73	
21	20.41	0.36	445	439.3	73	
22	20.32	0.37	495	422.3	73	
23	20.35	0.32	463	456.9	71	
24	20.43	0.24	524	448.2	68	
25	20.49	0.18	512	471.7	66	
26	20.54	0.12	502	484.1	62	
27	20.57	0.13	468	473.7	61	
28	20.59	0.11	445	459.7	60	
29	20.60	0.10	435	513.9	59	
30	20.62	0.05	391	559.7	58	
Ave.	19.60	0.93	682	506.2	102	
High	20.81	5.82	2331	963.8	197	
Low	15.11	0.05	18	83.1	58	

TEST DATA

LOCATION: 25 Lascelles Blvd, Toronto
SOURCE: Garbage Incinerator
DATE: 9 July 1986
START TIME: 1:39 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	18.46	1.47	5	49.7	90	
2	18.47	1.62	3	86.5	110	
3	17.78	3.81	201	118.6	127	
4	14.26	5.43	646	150.8	132	
5	14.87	3.83	1131	300.0	127	
6	15.35	4.58	1393	244.5	134	
7	14.45	5.30	1087	359.8	141	
8	14.79	4.60	1296	357.6	155	
9	14.26	5.88	1582	348.9	156	
10	13.92	5.14	1353	278.1	156	
11	13.68	5.84	1646	323.4	167	
12	13.39	5.56	1792	316.3	180	
13	13.84	4.75	2184	474.9	172	
14	14.88	3.68	2239	742.3	163	
15	15.84	3.10	1937	747.6	160	
16	16.49	2.86	1903	899.0	163	
17	16.51	2.96	1762	800.6	165	
18	16.42	2.88	1791	844.1	165	
19	16.67	2.55	1753	948.8	163	
20	17.05	2.41	1577	982.2	159	
21	17.33	2.26	1502	973.8	160	
22	17.45	2.21	1425	1044.9	160	
23	17.46	2.22	1458	1046.5	155	
24	17.54	2.06	1328	923.1	151	
25	17.55	2.26	1258	882.8	156	
26	17.26	2.32	1223	746.7	162	
27	17.36	2.12	1201	732.1	158	
28	17.60	2.01	1167	810.0	154	
29	17.81	1.85	1022	804.2	154	
30	18.01	1.79	947	788.3	150	
Ave.	16.22	3.31	1327	604.2	152	
High	18.47	5.88	2239	1046.5	180	
Low	13.39	1.47	3	49.7	90	

TEST DATA

LOCATION: 35 Brookwell Dr, Toronto
SOURCE: Garbage Incinerator
DATE: 10 July 1986
START TIME: 11:31 a.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	N.A.	N.A.	N.A.	152.0	69	afterburner was ignited
2	N.A.	N.A.	N.A.	106.5	76	before start of burning
3	N.A.	N.A.	N.A.	264.9	99	
4	N.A.	N.A.	N.A.	612.6	139	
5	N.A.	N.A.	N.A.	739.2	122	186.6 kg of garbage was
6	N.A.	N.A.	N.A.	831.9	125	fed in the first 20 min
7	20.85	0.04	11	618.2	174	
8	19.56	1.26	389	586.3	194	
9	19.24	1.20	722	621.5	184	O2,CO,CO2 values are
10	19.21	1.04	750	719.4	162	invalid for first 6 min
11	19.50	0.94	767	822.4	156	
12	19.59	0.73	638	825.2	145	
13	19.77	0.86	655	812.3	142	
14	19.34	1.35	698	709.4	127	
15	18.31	2.52	622	682.5	125	
16	17.40	2.56	582	644.2	265	
17	17.61	1.98	812	589.7	247	
18	17.96	2.17	852	473.6	250	
19	18.04	2.29	966	404.6	220	
20	17.87	1.86	879	521.3	217	
21	18.61	1.55	1028	602.2	197	
22	18.81	1.62	880	548.1	212	
23	18.35	2.08	802	466.9	250	
24	17.29	3.91	785	575.7	355	
25	15.12	4.90	323	590.1	365	
26	14.67	4.65	248	569.9	356	
27	15.13	3.98	217	544.9	343	
28	15.76	3.67	379	525.9	336	
29	16.03	3.36	487	386.7	326	
30	16.43	3.05	588	315.1	311	
Ave.	17.94	2.23	628	562.1	210	Ave. Feed: 124.4 kg/hr
High	20.85	4.90	1028	831.9	365	
Low	14.67	0.04	11	106.5	69	

TEST DATA

LOCATION: 130 Cosburn Ave, Toronto
SOURCE: Garbage Incinerator
DATE: 10 July 1986
START TIME: 7:22 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	20.75	1.79	80	56.3	169	20.6 kg of garbage was
2	16.49	4.41	216	85.4	249	previously loaded
3	14.63	5.32	2595	1263.6	250	
4	13.76	5.37	3244	740.7	267	
5	13.69	5.33	3238	635.0	280	
6	14.02	4.62	1073	104.5	284	
7	14.73	4.20	248	72.5	280	
8	15.14	3.71	183	103.7	283	
9	15.70	3.59	188	84.9	284	
10	16.12	3.02	172	77.8	278	
11	17.00	2.78	133	65.8	276	
12	17.17	2.69	124	61.0	279	
13	17.18	2.77	138	58.4	278	
14	17.08	2.68	117	43.2	276	
15	17.16	2.62	127	65.4	280	
16	17.27	2.61	132	65.8	284	
17	17.23	3.13	118	59.4	294	
18	16.45	3.38	150	63.5	304	
19	16.35	3.33	155	65.0	304	
20	16.36	3.32	156	68.1	305	
21	16.33	3.28	174	65.2	306	
22	16.49	3.15	164	61.7	305	
23	16.57	3.09	162	56.6	307	additional 17.4 kg was
24	16.21	4.83	1220	62.9	315	fed in 1 minute
25	14.08	5.50	3243	910.9	317	
26	13.46	5.73	3108	557.4	334	
27	13.40	5.65	2510	326.1	339	
28	13.43	5.63	2445	292.1	341	
29	13.54	5.40	1136	127.2	351	
30	13.93	5.11	404	117.7	349	
Ave.	15.72	3.93	905	213.9	292	Ave. Feed: 76.0 kg/hr
High	20.75	5.73	3244	1263.6	351	
Low	13.40	1.79	80	43.2	169	

TEST DATA

LOCATION: 39 Brookwell Dr, Toronto
SOURCE: Garbage Incinerator
DATE: 11 July 1986
START TIME: 11:54 a.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	20.42	2.75	97	21.6	411	83.0 kg of garbage was
2	15.85	4.48	541	54.2	415	previously loaded
3	14.94	4.06	857	98.0	400	
4	14.96	4.18	1053	123.1	398	garbage and afterburner
5	14.80	4.11	1043	169.5	402	ignition at 11:50 a.m.
6	14.95	4.03	857	216.3	412	
7	15.12	3.79	948	229.0	406	data from 11:50 to 11:54
8	15.22	3.81	765	192.0	404	unrecorded
9	15.27	3.64	678	215.3	400	
10	15.56	3.37	690	199.4	390	
11	15.71	3.69	709	190.9	384	
12	15.07	4.06	780	195.7	416	
13	14.81	4.23	753	202.8	426	
14	14.75	4.00	811	201.6	428	
15	15.03	3.74	905	185.6	420	
16	15.29	3.60	798	174.1	417	
17	15.48	3.53	722	184.6	417	
18	15.43	3.51	707	176.3	421	
19	15.33	3.64	729	174.0	428	
20	15.15	3.69	628	183.2	425	
21	15.29	3.51	584	176.9	426	
22	15.57	2.85	586	151.3	420	
23	17.07	1.82	778	138.1	370	approximately 40.0 kg
24	17.73	1.99	1074	284.9	335	more fed in 7 minutes
25	17.21	2.31	927	629.9	350	
26	17.21	2.53	1079	462.3	351	
27	16.23	3.09	707	499.7	392	
28	16.11	3.17	739	562.4	395	
29	16.01	2.82	649	255.3	407	
30	15.96	3.74	565	262.0	413	
Ave.	15.78	3.46	759	227.0	403	Ave. Feed: 166.0 kg/hr
High	20.42	4.48	1079	629.9	428	
Low	14.75	1.82	97	21.6	335	

TEST DATA

LOCATION: 230 Woolner, Toronto
SOURCE: Garbage Incinerator
DATE: 18 July 1986
START TIME: 11:18 a.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (C)	Observations
1	17.84	2.41	571	68.3	169	77.5 kg of garbage was
2	17.56	2.16	842	345.2	276	previously loaded
3	17.71	2.14	840	460.2	254	
4	17.82	2.04	762	471.6	256	garbage and afterburner
5	18.02	1.98	809	488.2	246	ignition at 11:18 a.m.
6	17.98	2.02	881	536.3	252	
7	17.99	1.97	884	533.2	247	
8	17.98	2.08	815	545.6	249	
9	17.82	2.06	822	499.4	267	
10	17.89	1.97	921	557.0	272	
11	18.14	1.80	941	612.7	268	
12	18.35	1.71	999	680.2	252	
13	18.35	1.72	1102	769.2	243	
14	18.27	1.80	1262	946.4	246	
15	18.18	1.81	1351	253.1	249	
16	18.27	1.67	1357	956.5	256	
17	18.33	1.78	1388	1032.4	247	
18	18.14	1.78	1358	1152.8	258	
19	18.27	1.66	1216	1044.7	256	
20	18.48	1.55	1080	956.1	250	
21	18.56	1.56	1140	958.9	240	
22	18.55	1.55	1187	1091.6	237	
23	18.63	1.49	1149	1038.6	236	
24	18.66	1.47	1072	983.4	233	
25	18.68	1.46	1018	932.4	235	
26	18.69	1.48	1029	939.9	234	
27	18.61	1.49	995	935.4	234	
28	18.62	1.48	967	930.2	237	
29	18.59	1.54	913	925.3	237	
30	18.50	1.52	893	872.1	235	
Ave.	18.25	1.77	1019	750.6	246	Estd. Feed: 77.5 kg/hr
High	18.69	2.41	1388	1152.8	276	
Low	17.56	1.46	571	68.3	169	

TEST DATA

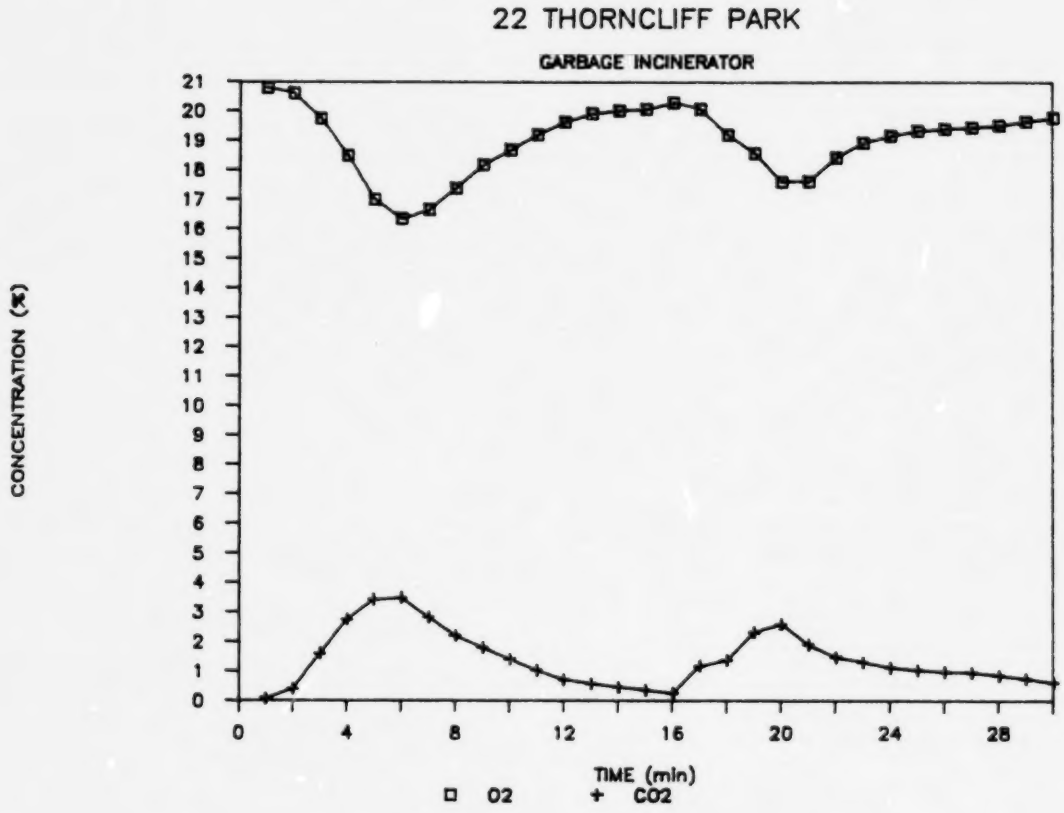
LOCATION: 220 Woolner, Toronto
SOURCE: Garbage Incinerator
DATE: 18 July 1986
START TIME: 2:20 p.m.

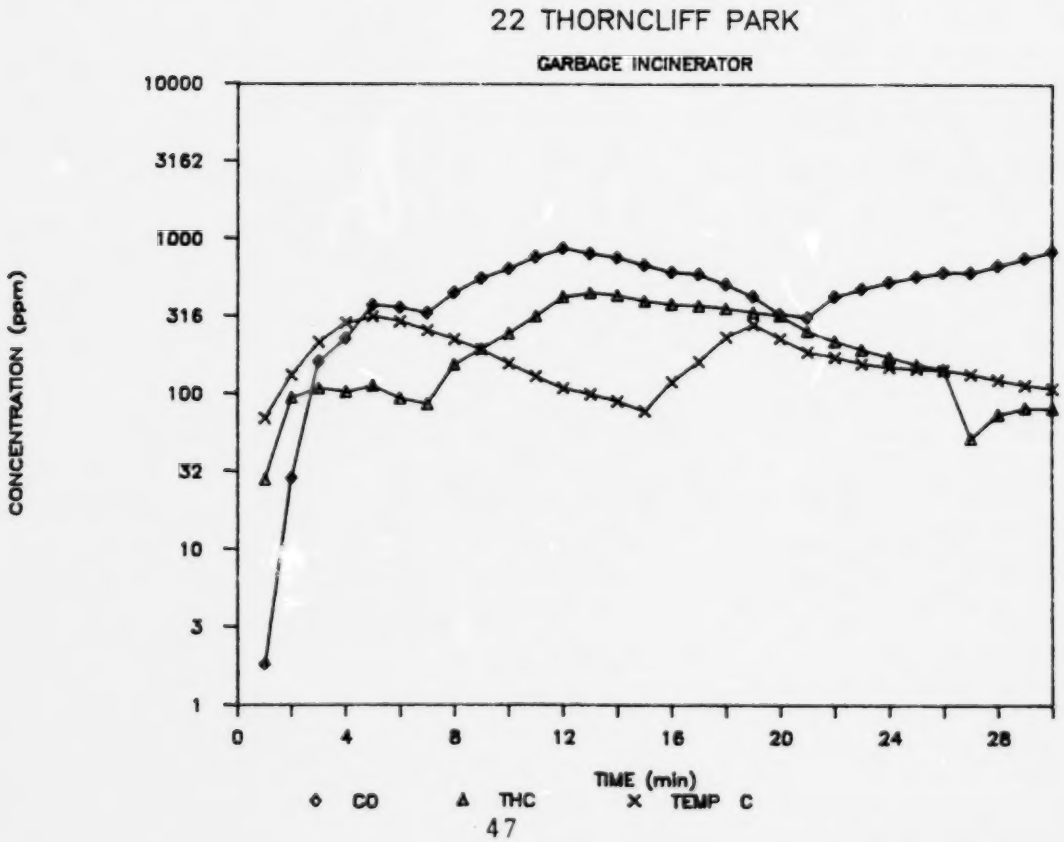
TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (C)	Observations
1	20.65	0.37	370	333.5	N.A.	approximately 87.0 kg
2	18.92	2.51	2767	1150.6	N.A.	was previously loaded
3	16.48	3.85	2481	1274.4	N.A.	
4	16.07	3.48	219	884.8	220	garbage and afterburner
5	16.77	2.91	89	225.1	222	ignition at 2:20 p.m.
6	16.91	2.96	85	163.6	214	
7	16.71	3.29	89	142.6	213	temperature data
8	16.37	3.27	193	132.2	208	invalid for first
9	16.59	2.86	304	123.5	206	3 minutes
10	16.94	2.70	1031	119.9	202	
11	17.19	2.53	1372	152.0	206	
12	17.21	2.51	1891	220.6	204	
13	17.36	2.29	2323	353.2	188	
14	17.72	2.03	1867	374.6	198	
15	18.08	1.74	1694	421.5	196	
16	18.33	1.89	1960	722.9	196	
17	18.12	1.85	1647	531.0	192	
18	18.11	1.92	1721	594.8	196	afterburner off at 2:38
19	18.04	1.91	1922	495.7	188	
20	18.04	1.92	1962	464.2	161	
21	17.99	1.85	2049	433.7	140	
22	18.21	1.61	2048	530.4	125	
23	18.99	1.18	1285	803.2	118	
24	19.30	1.02	1242	996.7	113	
25	19.55	0.90	1221	1130.7	109	
26	19.61	0.87	1071	966.6	108	
27	19.60	0.85	1072	995.9	103	
28	19.68	0.88	1106	1023.3	100	
29	19.66	0.81	1194	1171.6	94	
30	19.83	0.66	1116	1142.2	91	
Ave.	18.10	1.98	1313	602.5	150	Estd. Feed: 174.0 kg/hr
High	20.65	3.85	2767	1274.4	222	
Low	16.07	0.37	85	119.9	91	

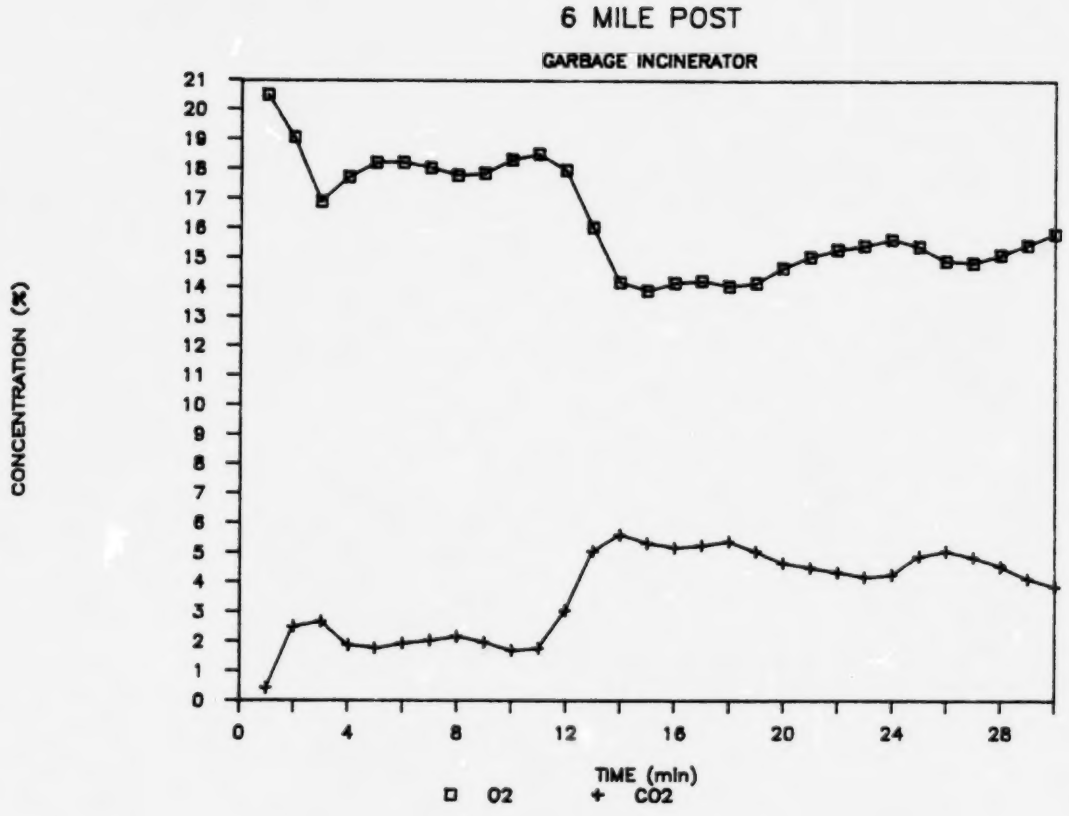
Appendix C

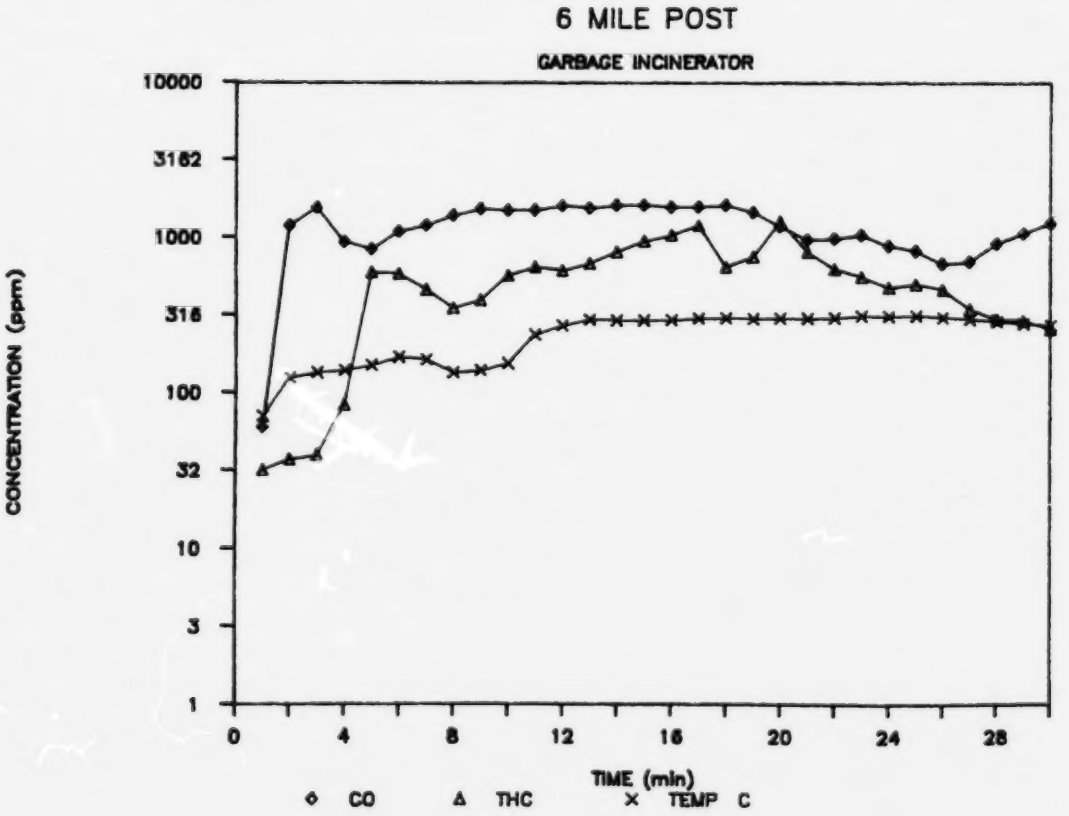
TEST DATA PLOTS

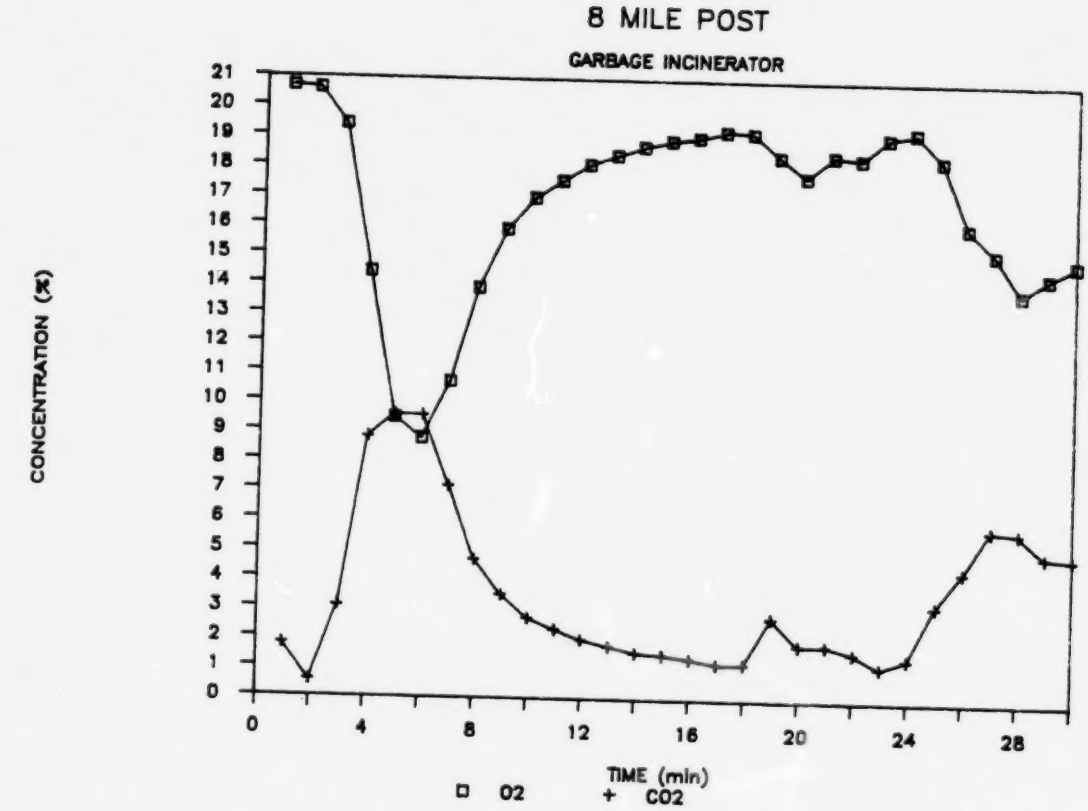
First Half Hour

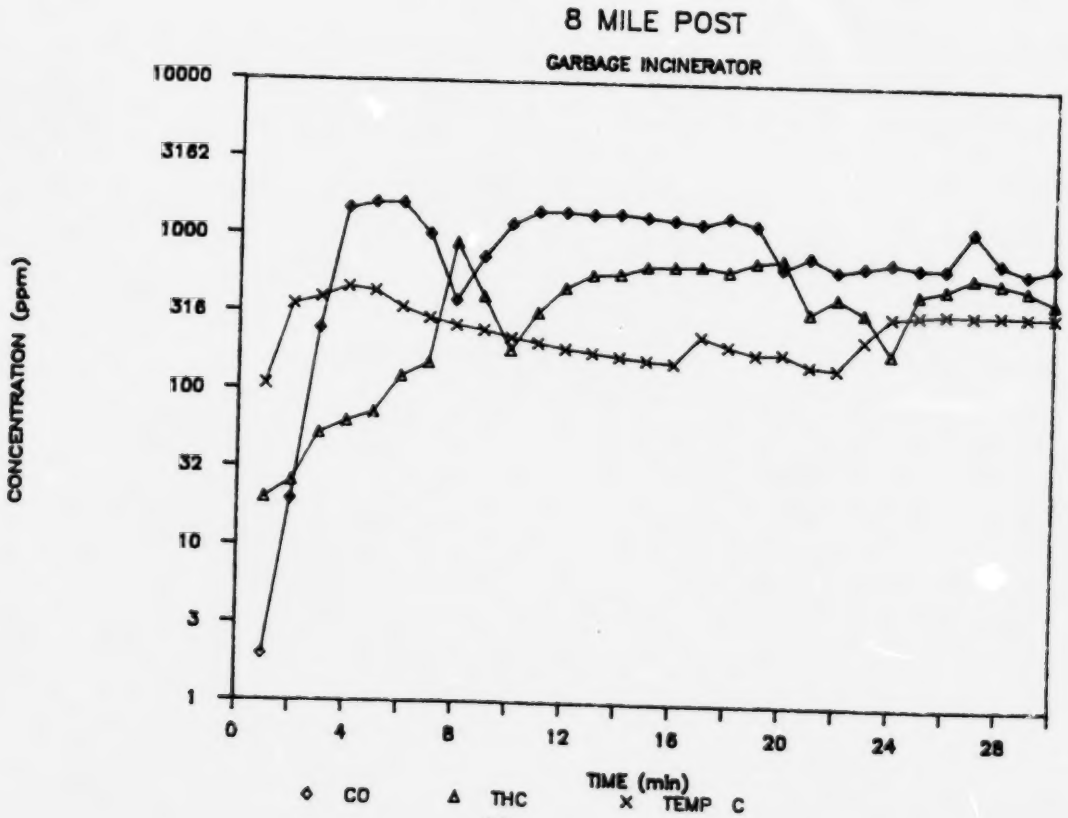

22 THORNCLIFF PARK
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ O2
+ CO2

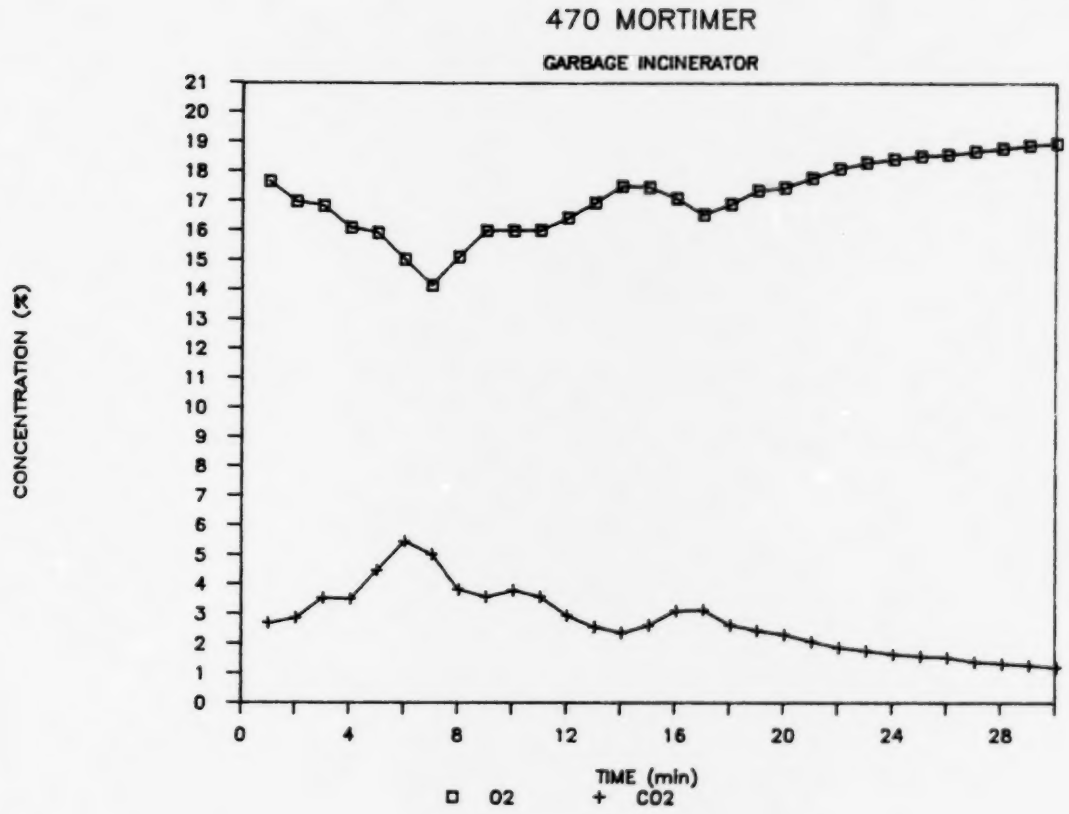

22 THORNCLIFF PARK
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C

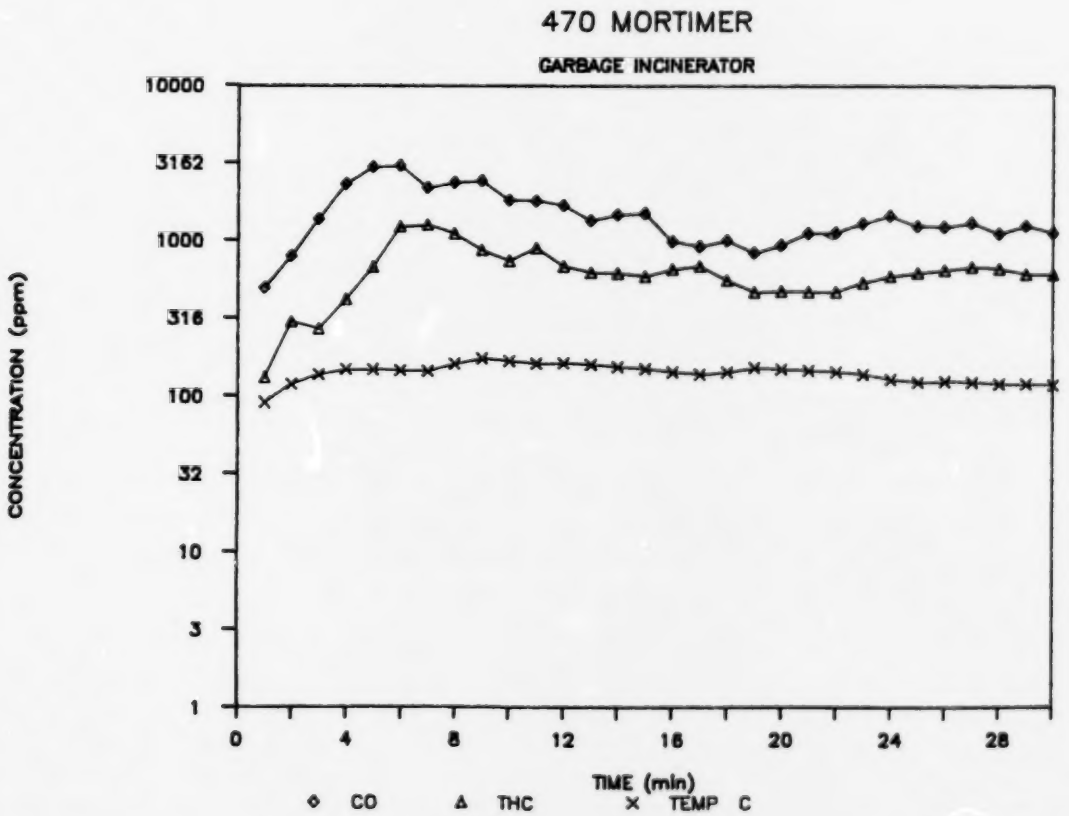

6 MILE POST
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
O2
CO2

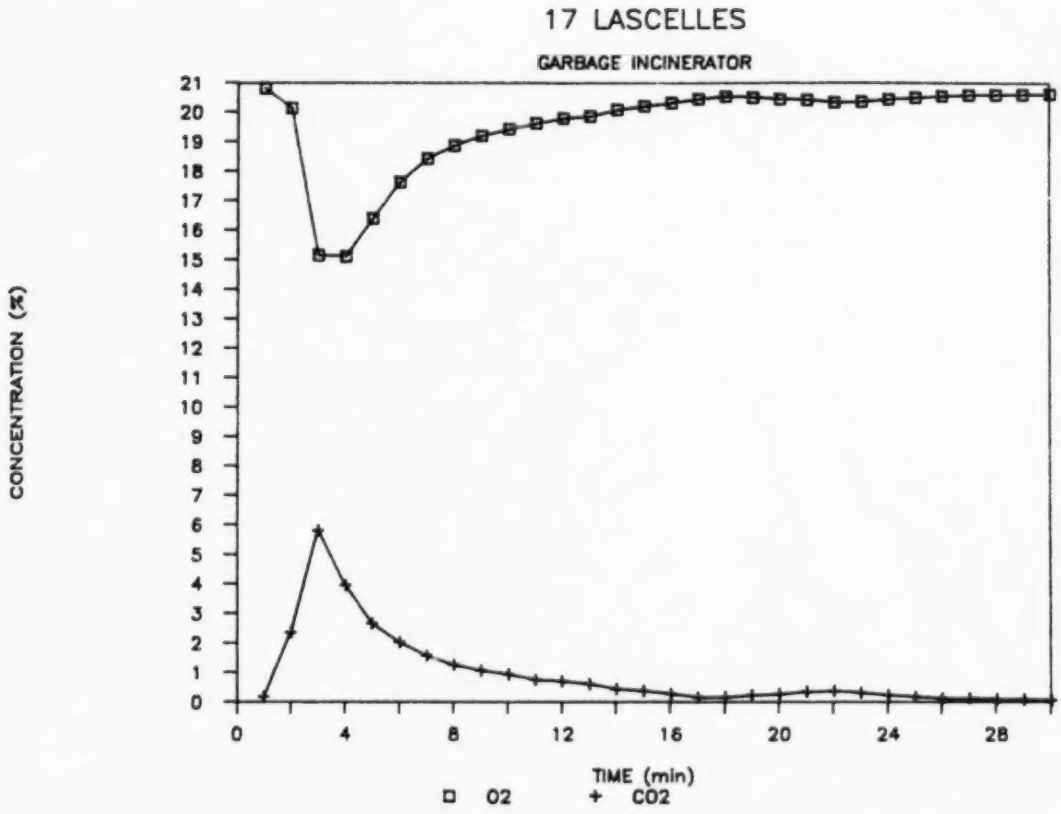

6 MILE POST
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
CO
THC
TEMP C

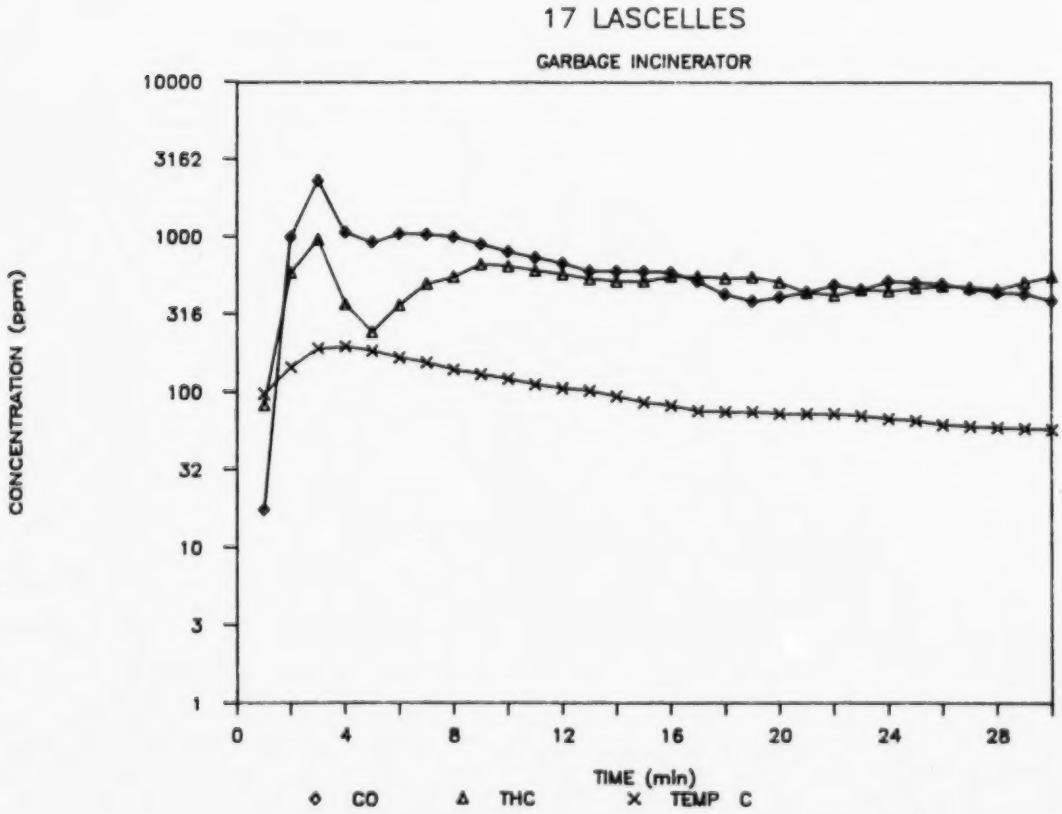

8 MILE POST
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ O2
+ CO2

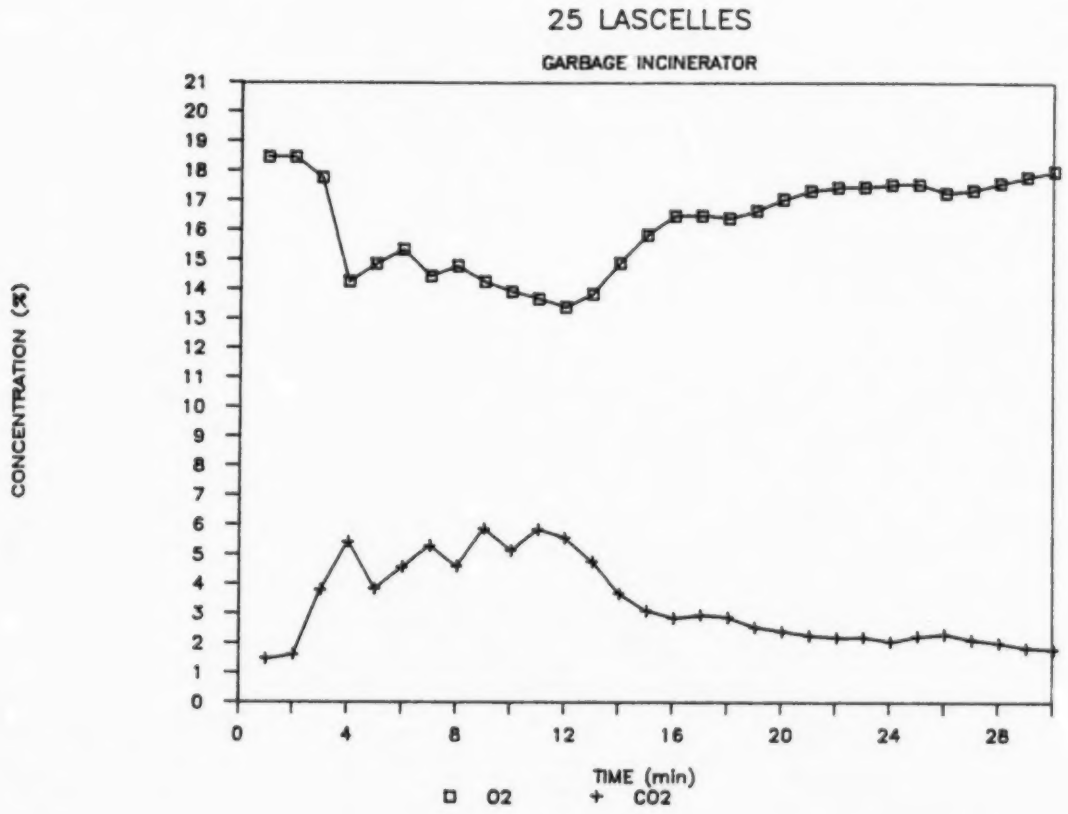

8 MILE POST
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C

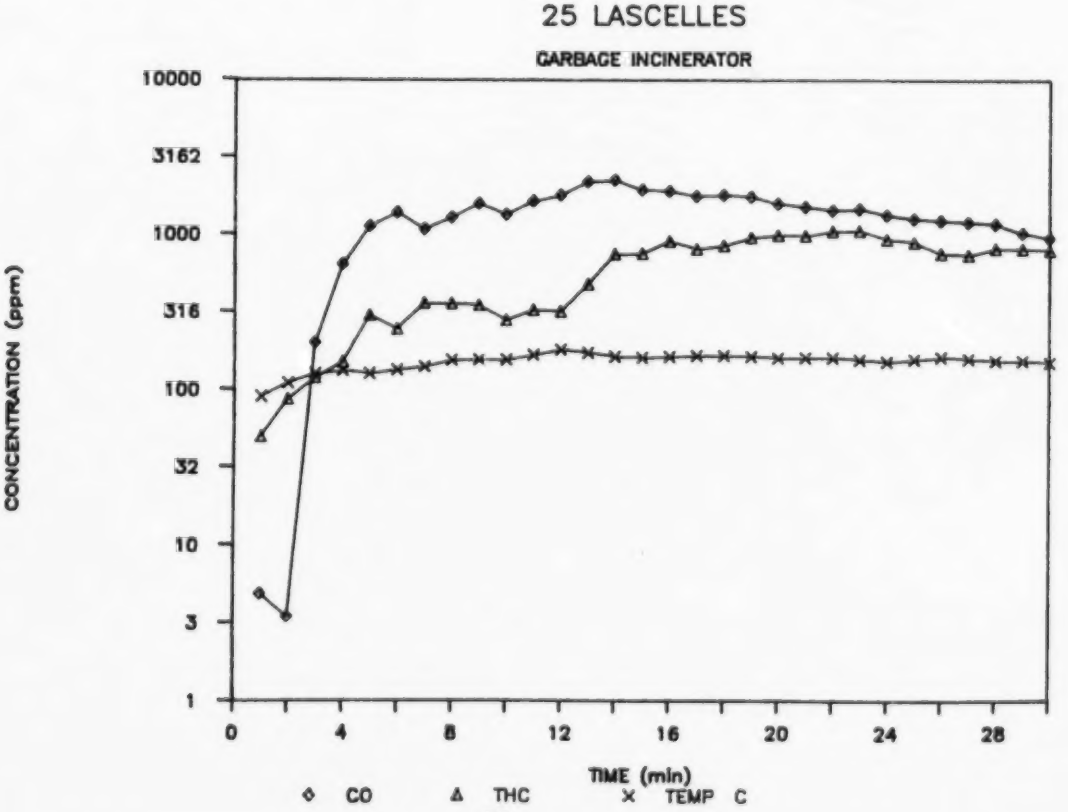

470 MORTIMER
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ O2
+ CO2

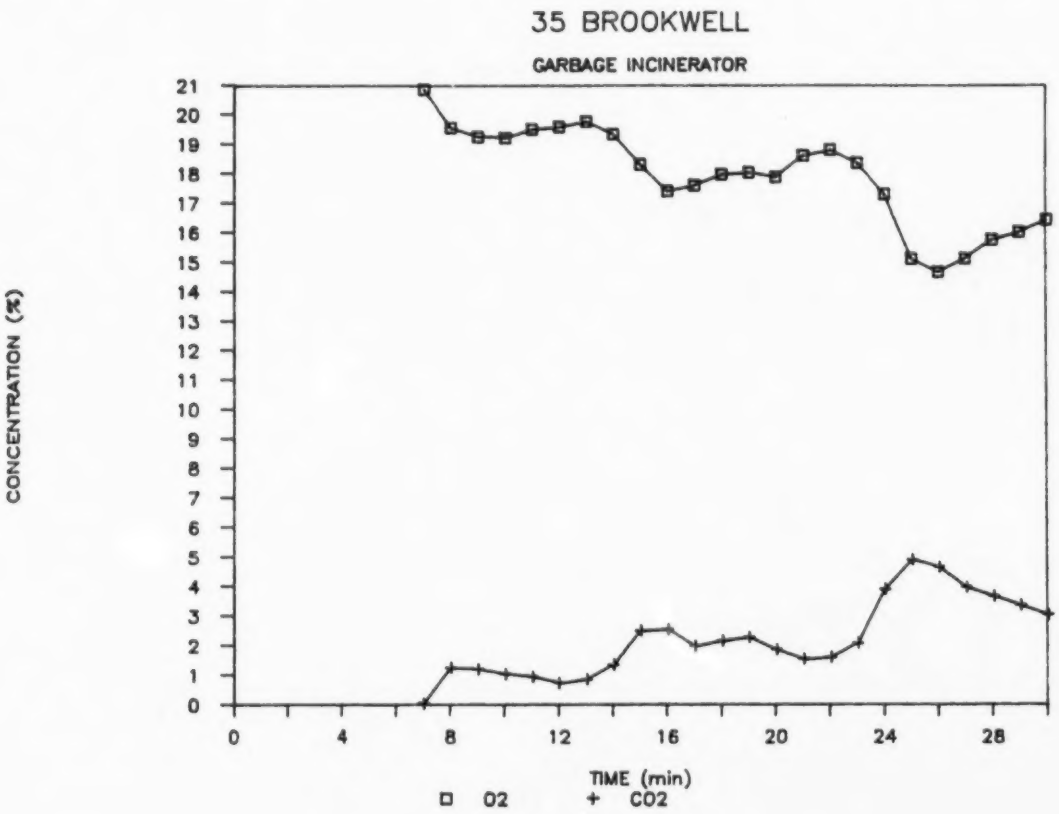

470 MORTIMER
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C

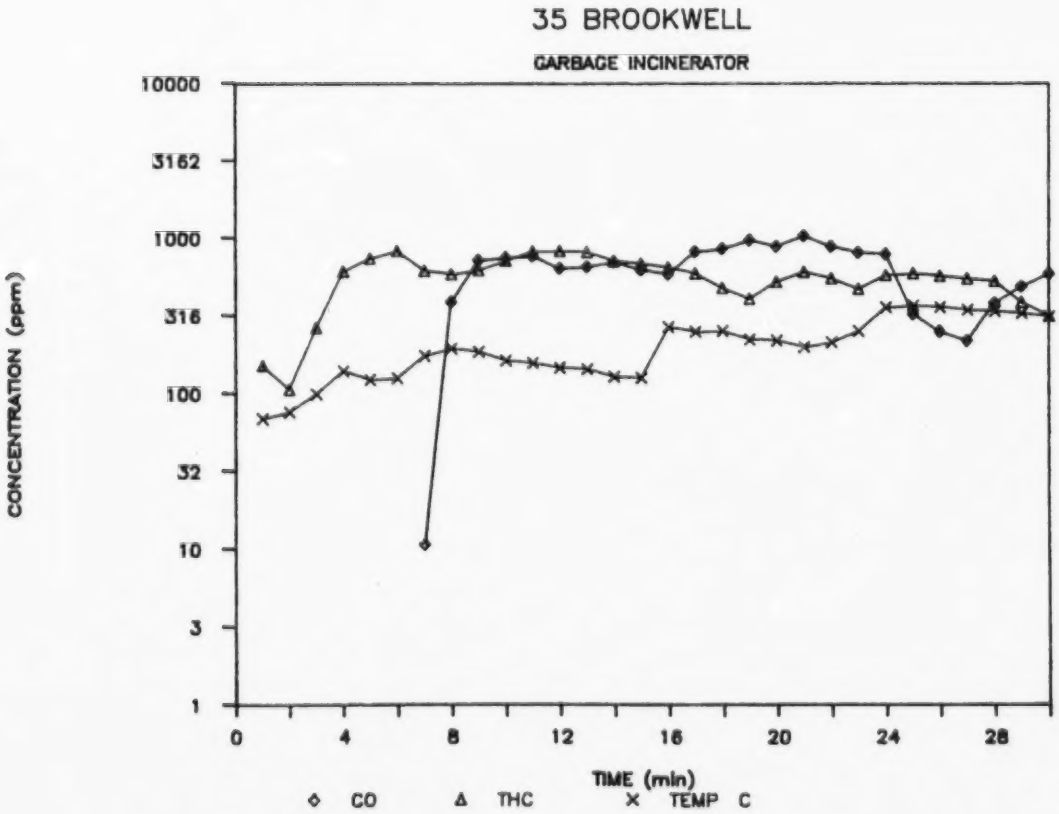

17 LASCELLES
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ O2
+ CO2

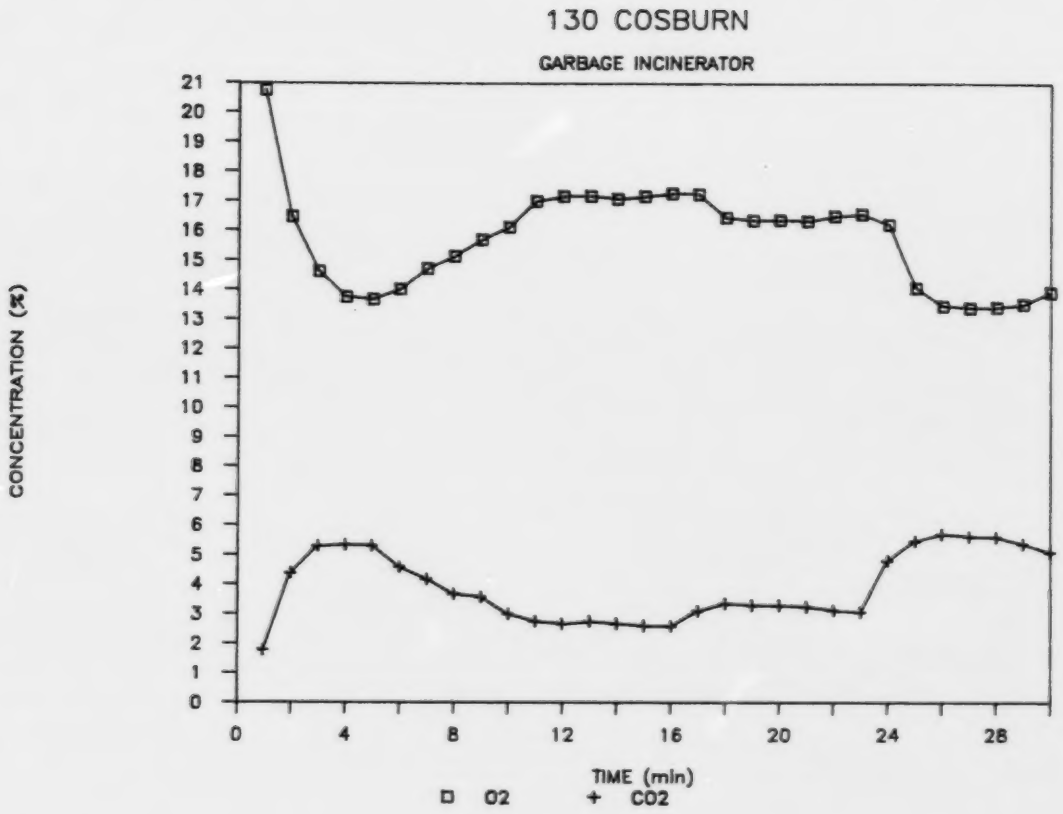

17 LASCELLES
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C

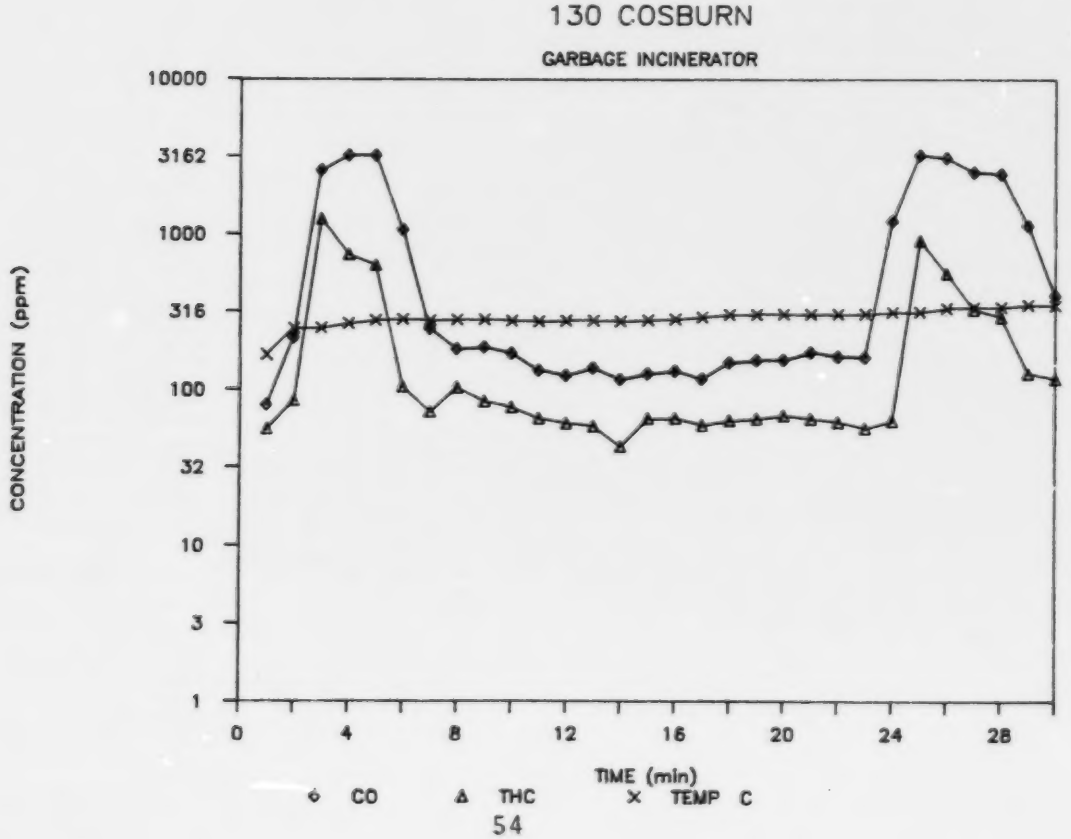

25 LASCELLES
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ O2
+ CO2

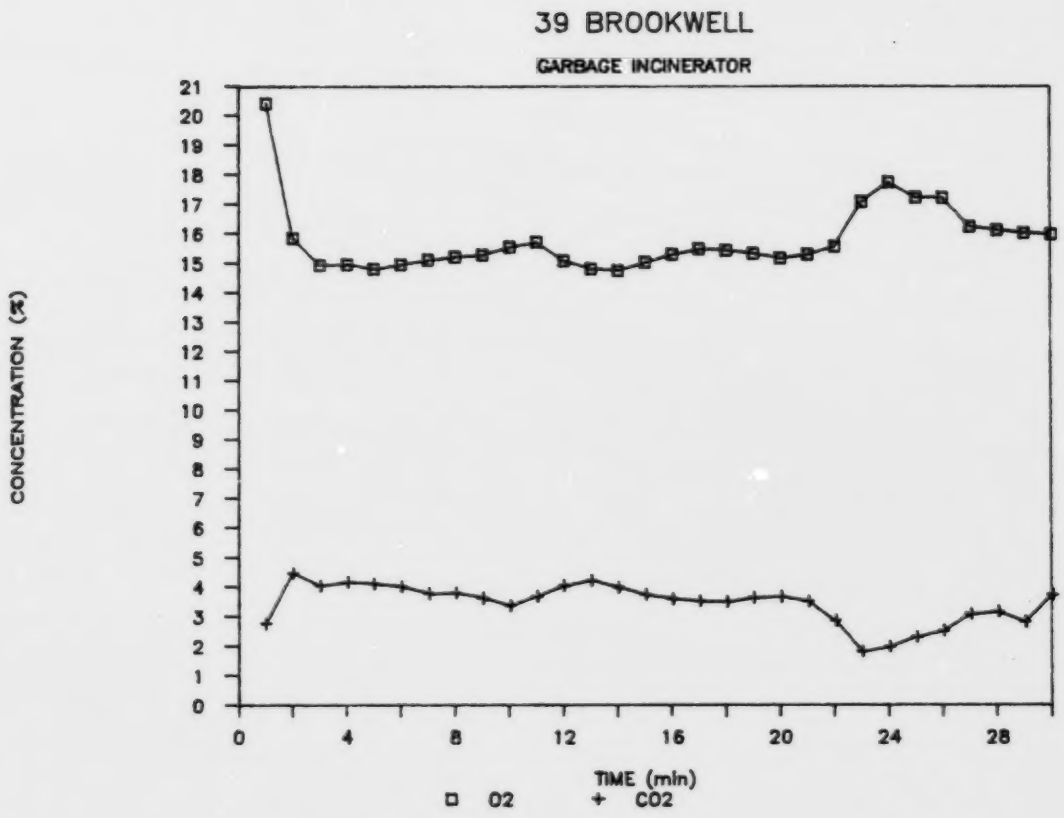

25 LASCELLES
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C

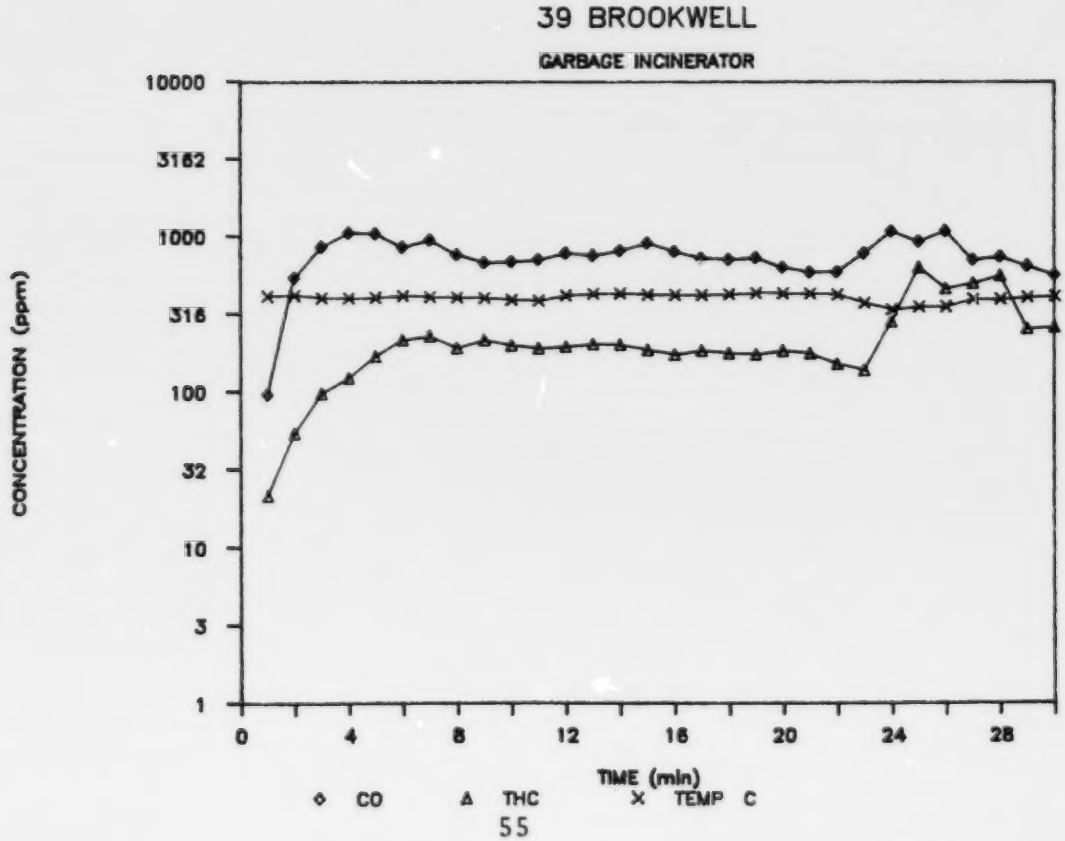

35 BROOKWELL
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ O2
+ CO2

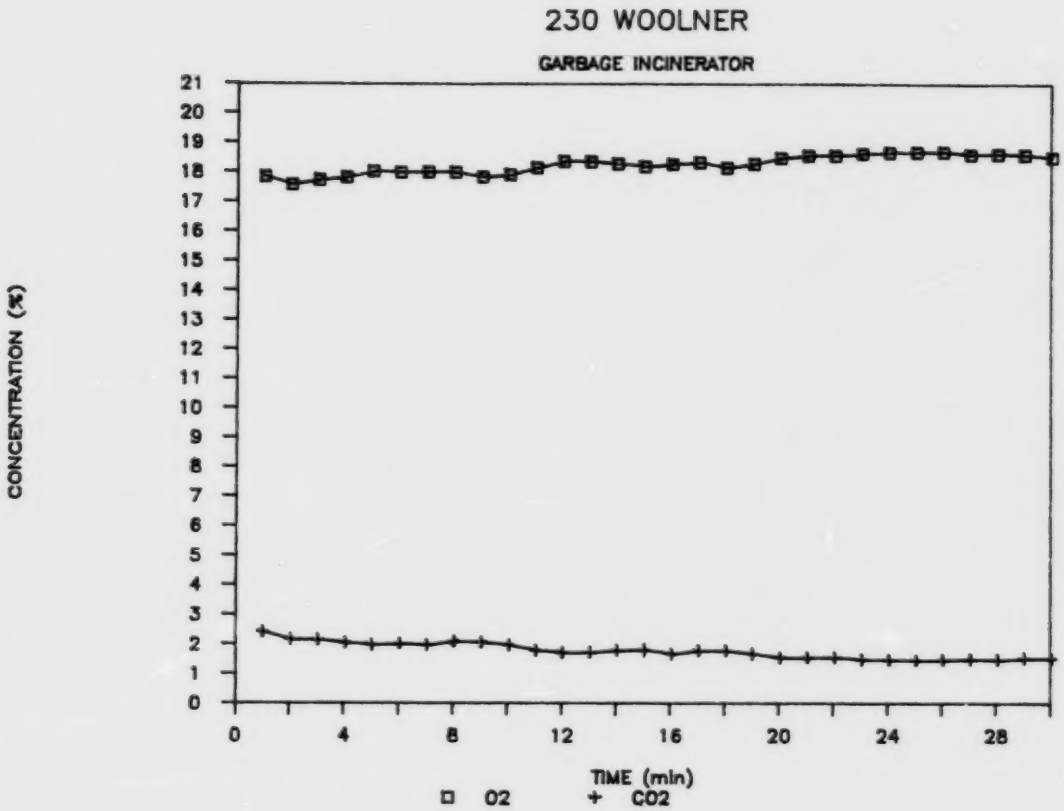

35 BROOKWELL
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C

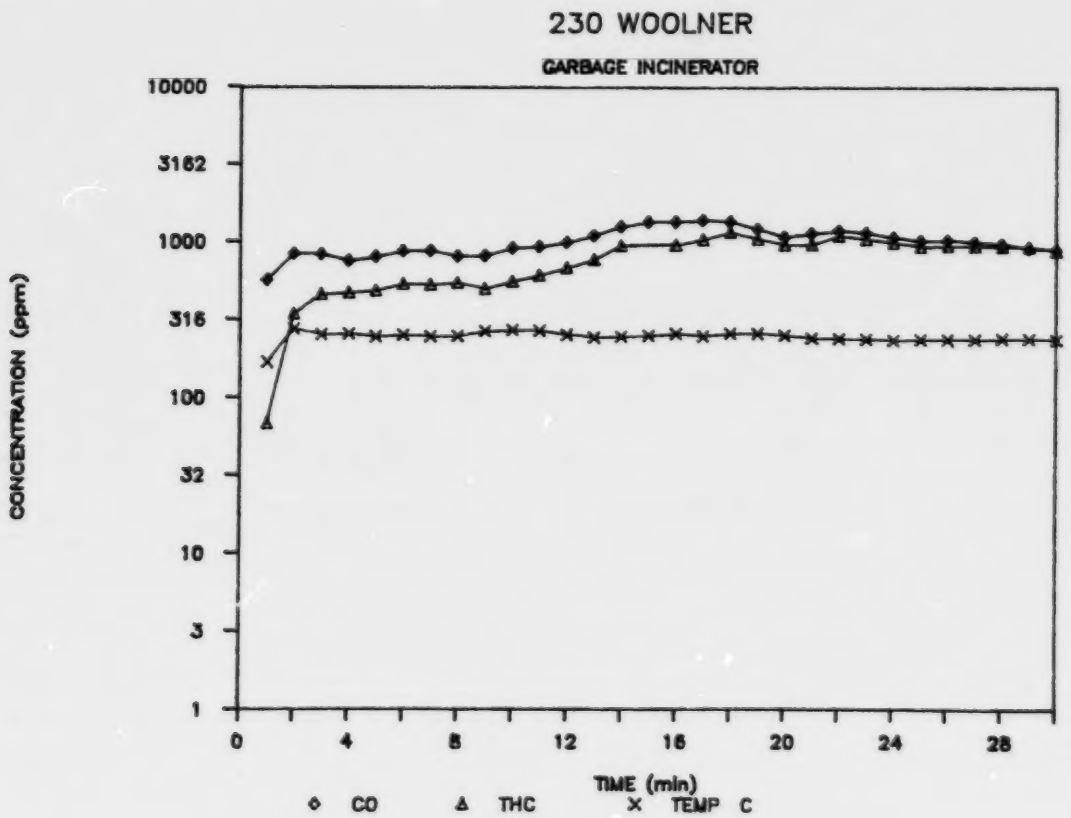

130 COSBURN
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ O2
+ CO2

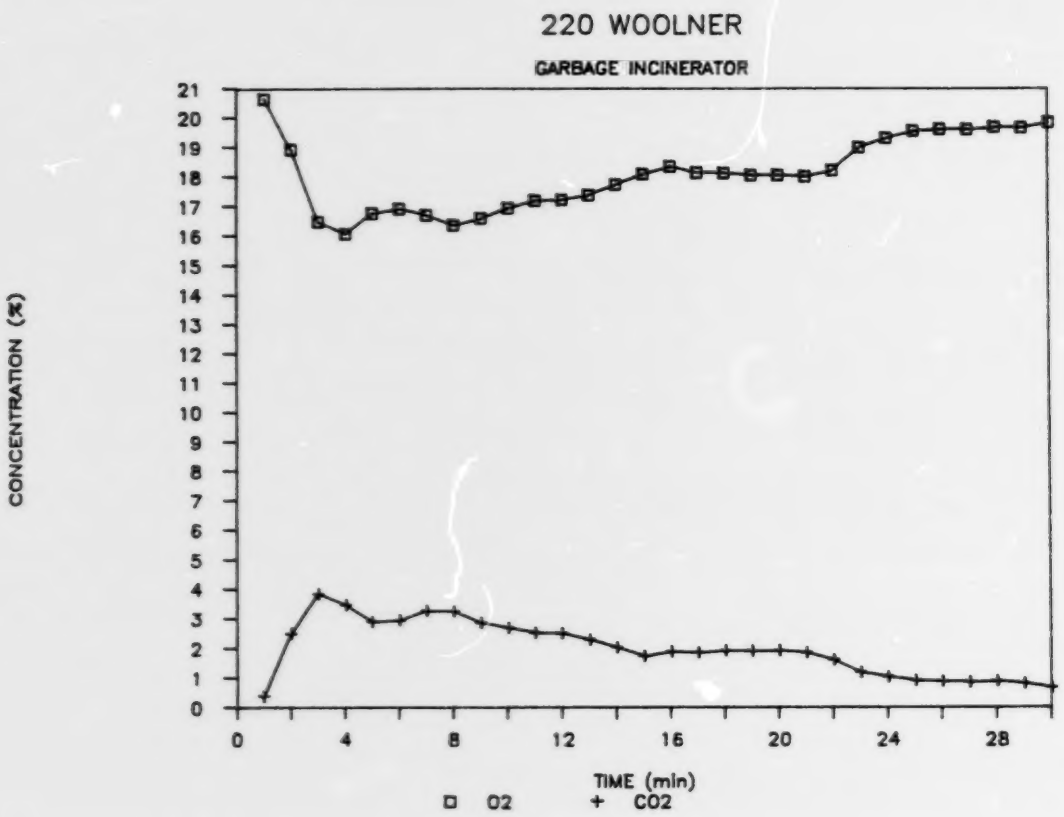

130 COSBURN
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C

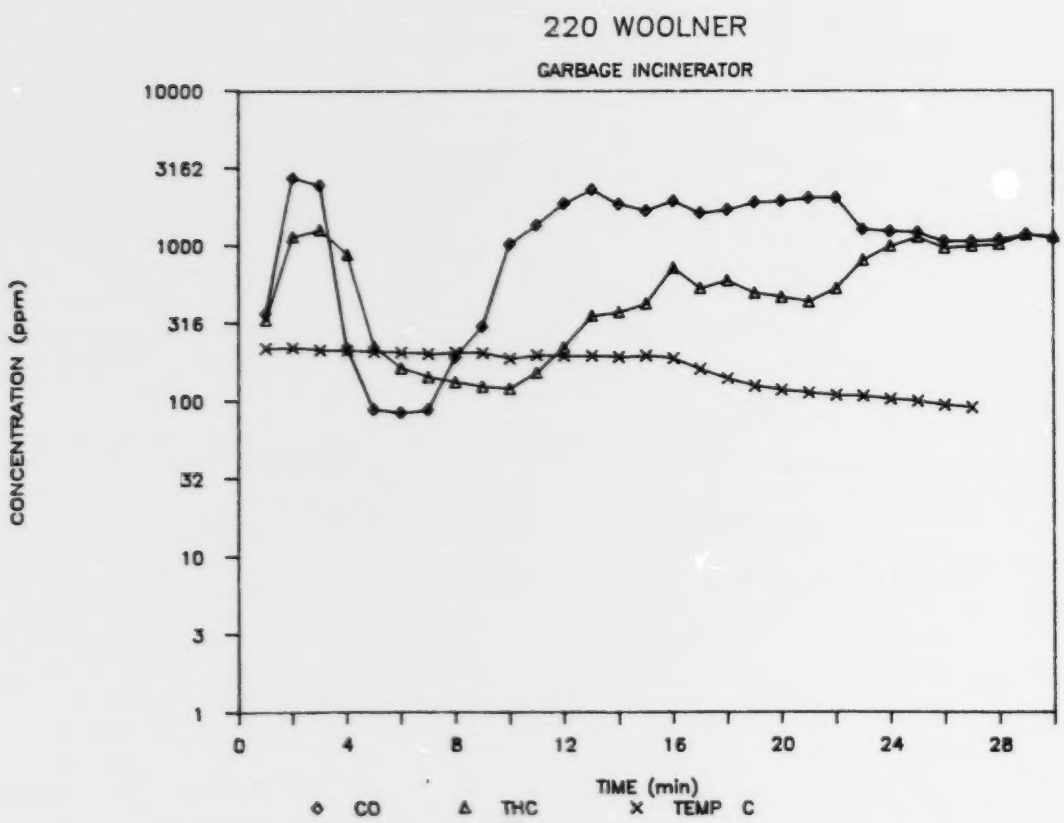

39 BROOKWELL
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ 02
+ CO2


39 BROOKWELL
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C


230 WOOLNER
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ O2
+ CO2


230 WOOLNER
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C


220 WOOLNER
GARBAGE INCINERATOR
CONCENTRATION (%)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0
4
8
12
16
20
24
28
TIME (min)
□ O2
+ CO2

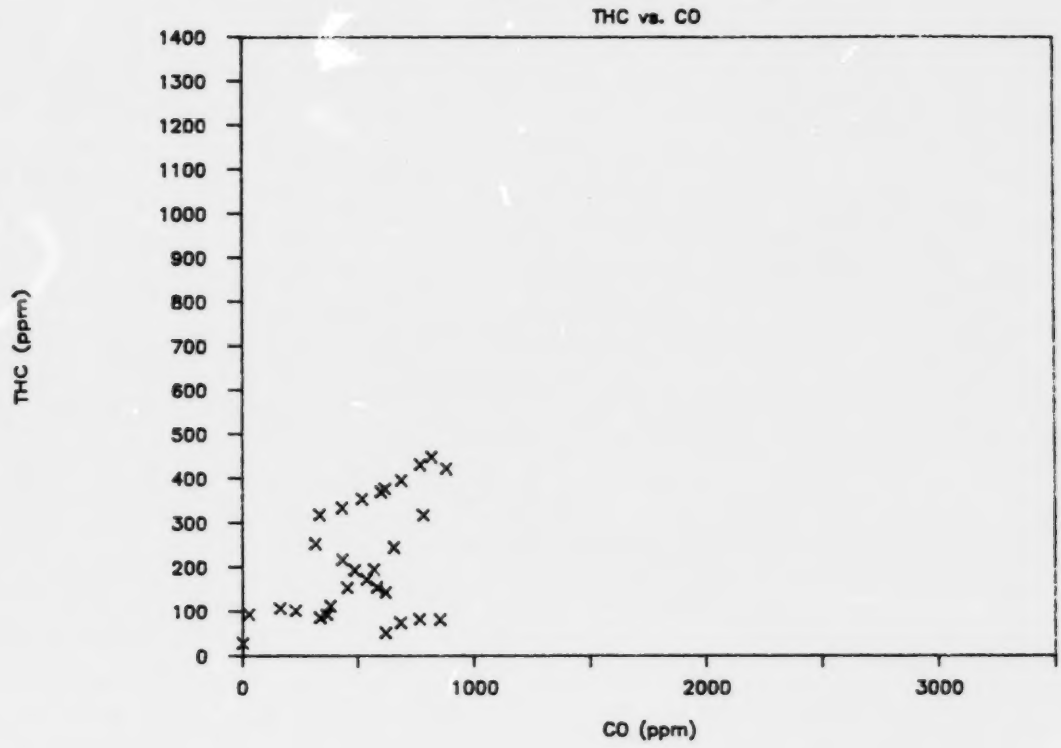

220 WOOLNER
GARBAGE INCINERATOR
CONCENTRATION (ppm)
10000
3162
1000
316
100
32
10
3
1
0
4
8
12
16
20
24
28
TIME (min)
◇ CO
△ THC
× TEMP C

Appendix D

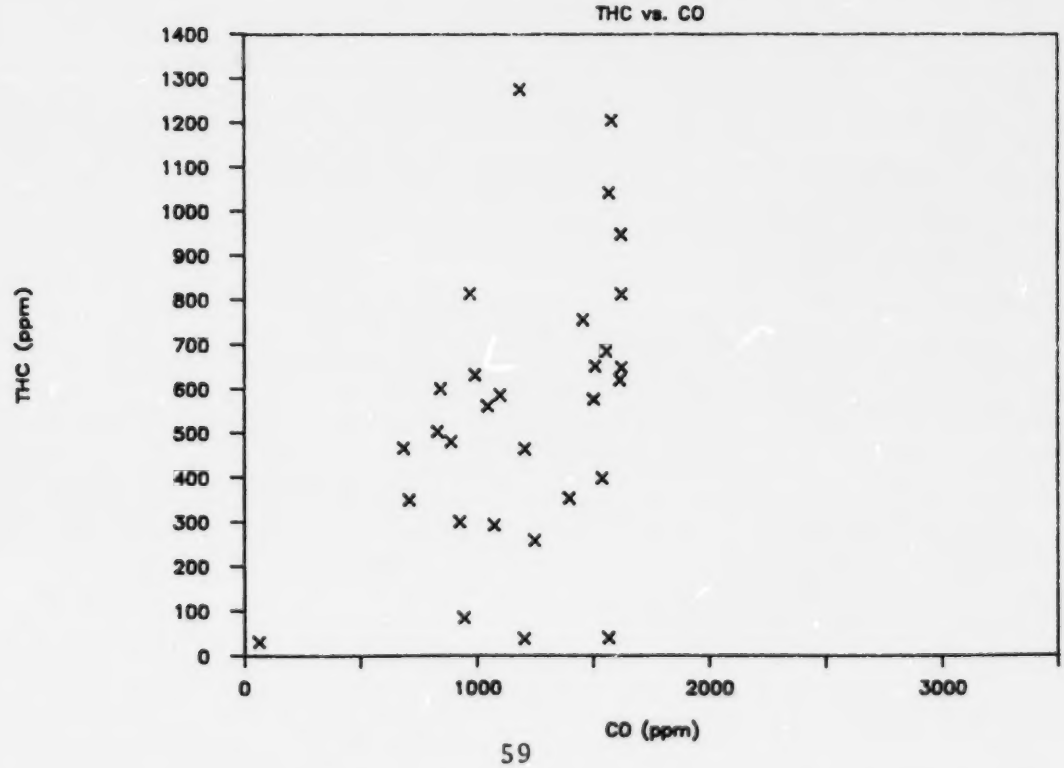
THC vs CO CORRELATION

First Half Hour

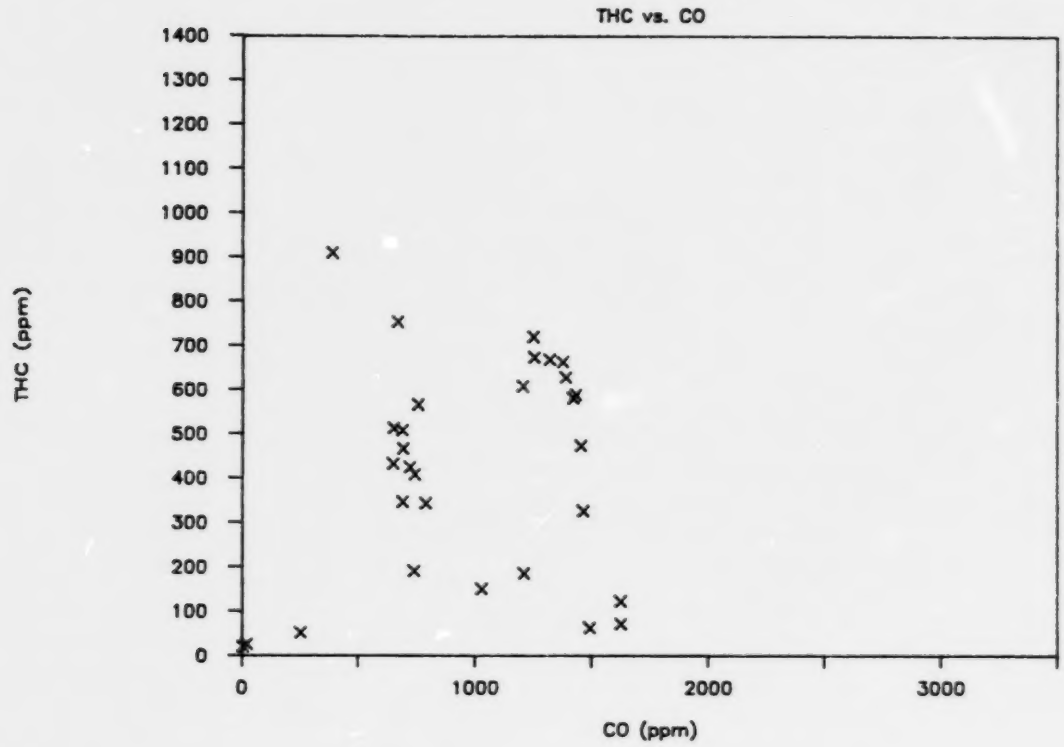
22 THORNCLIFF PARK



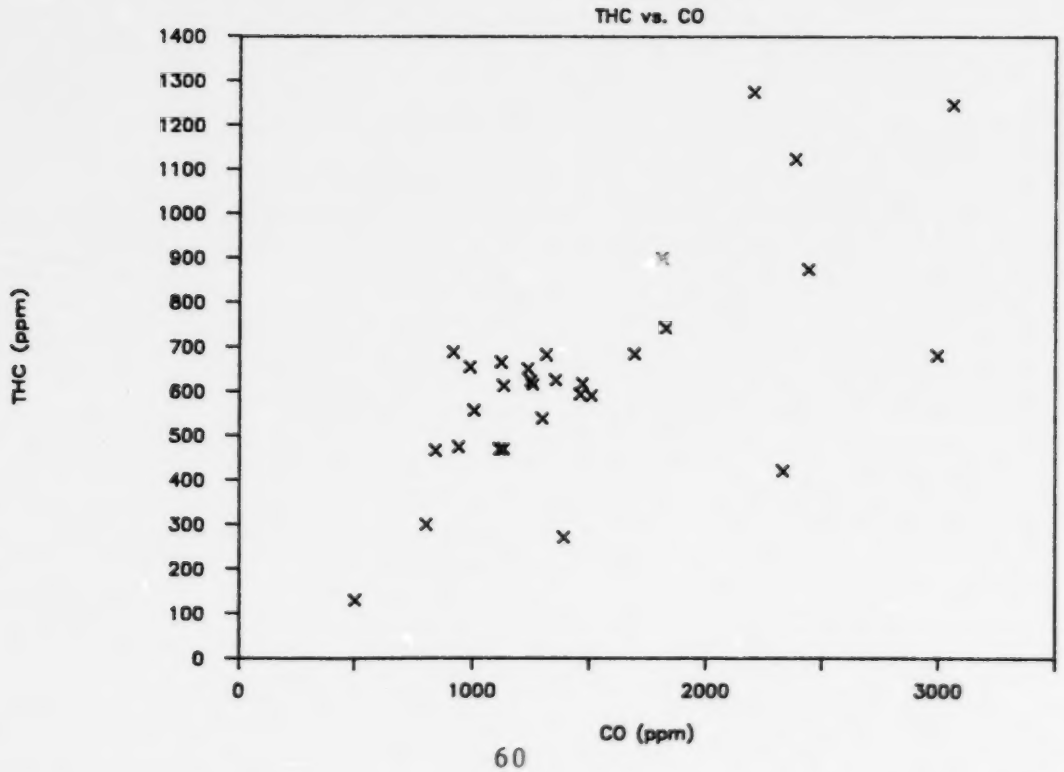
6 MILE POST

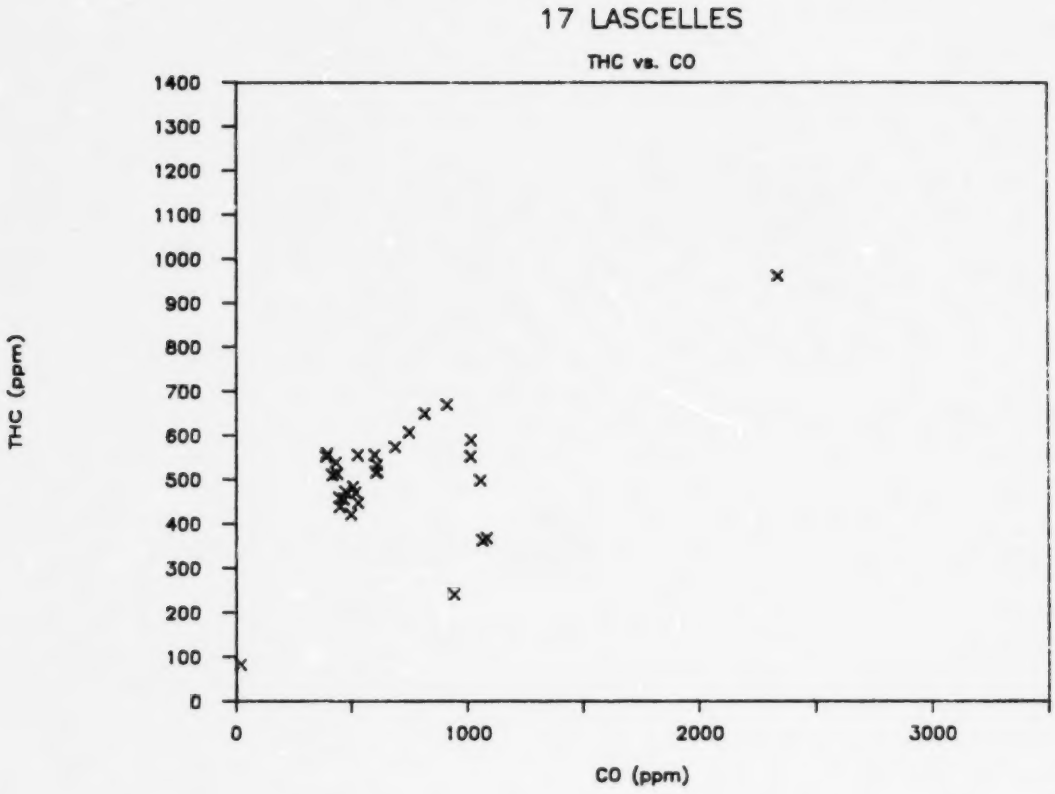


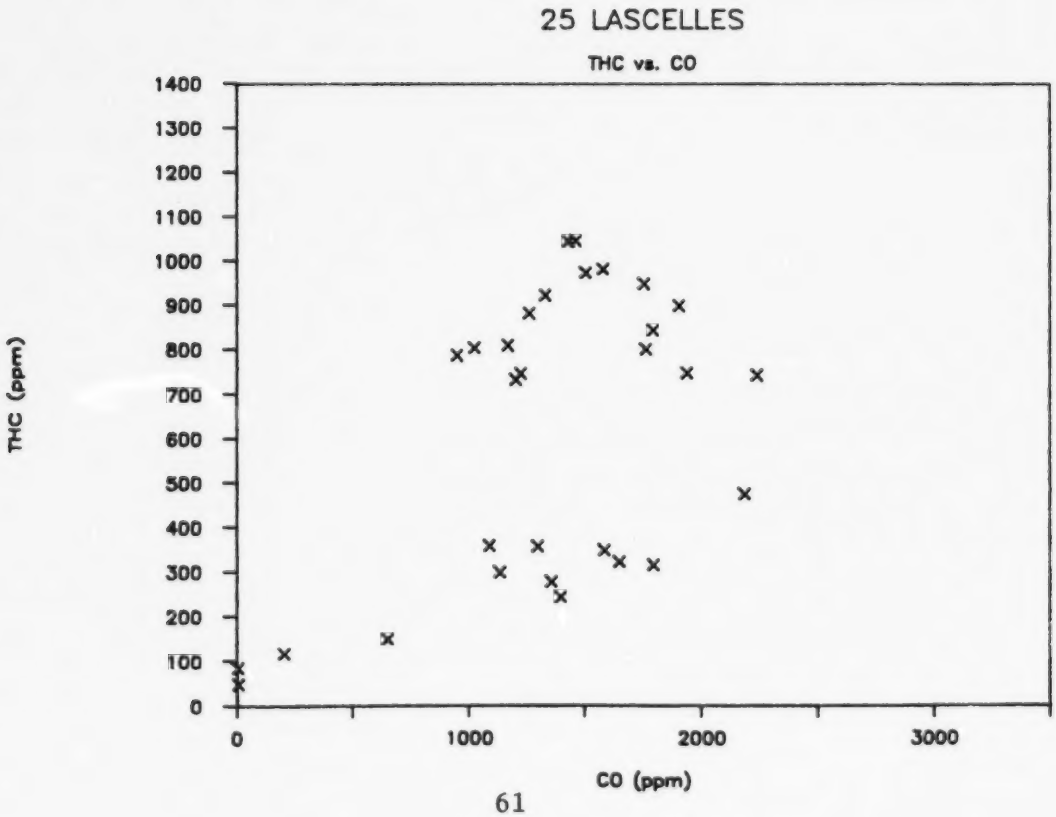
8 MILE POST

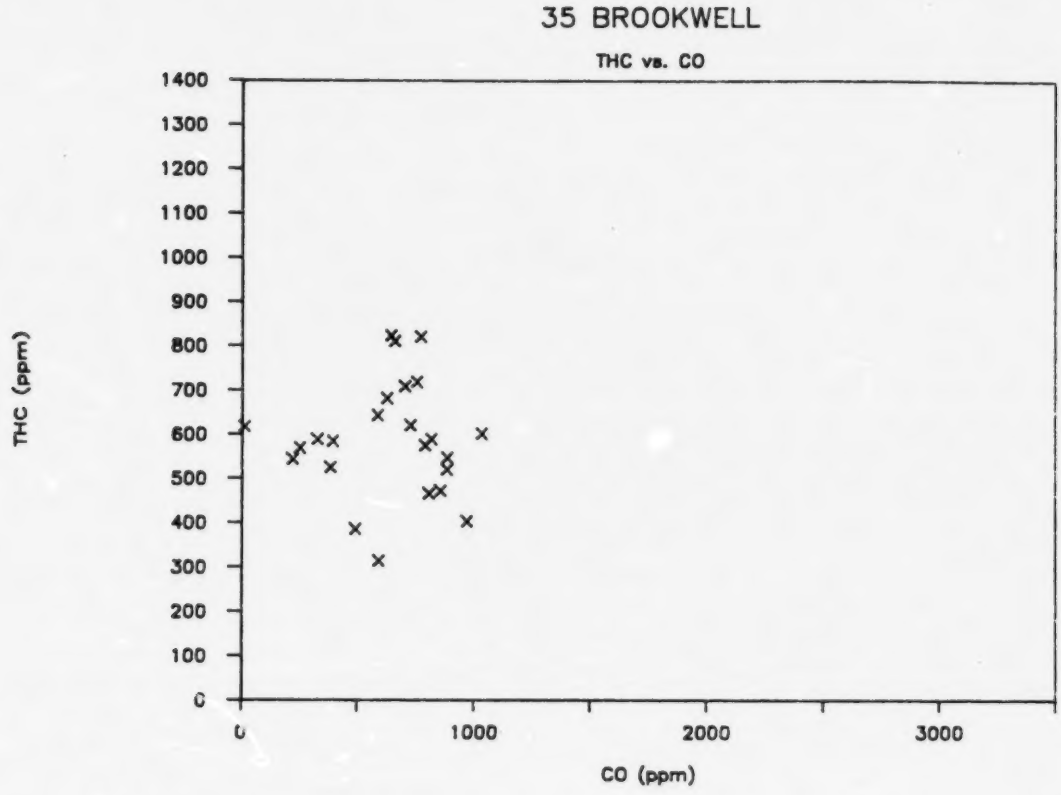


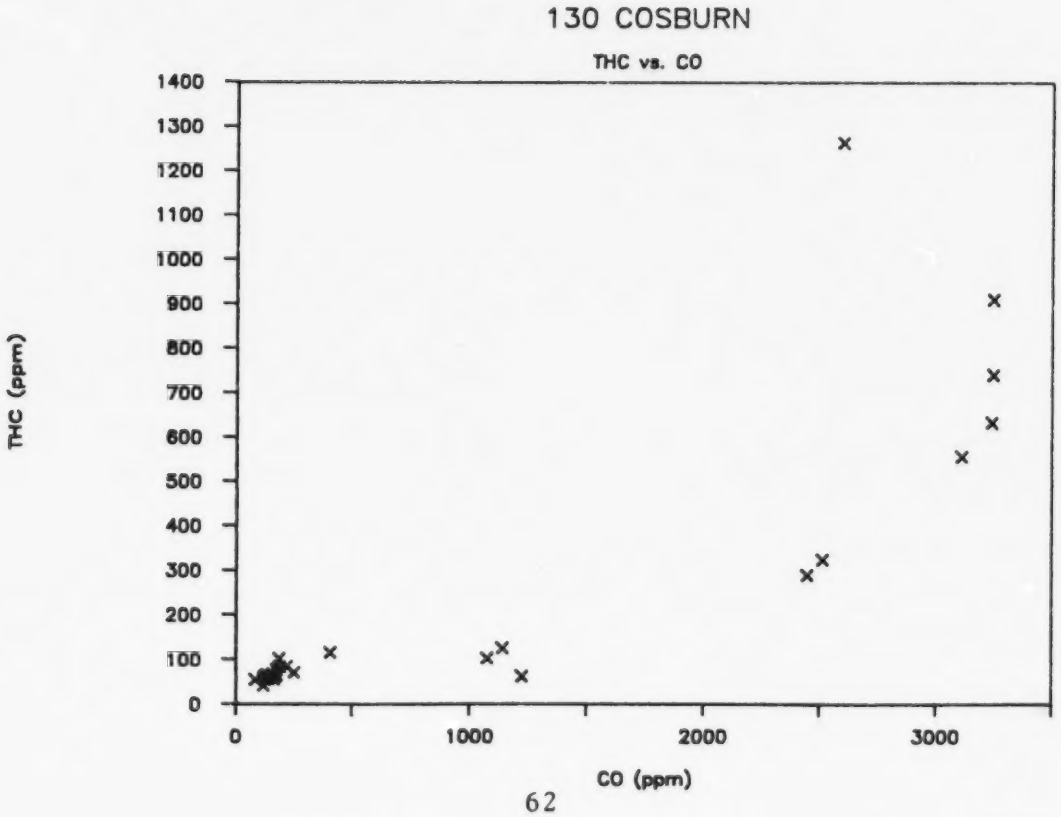
470 MORTIMER

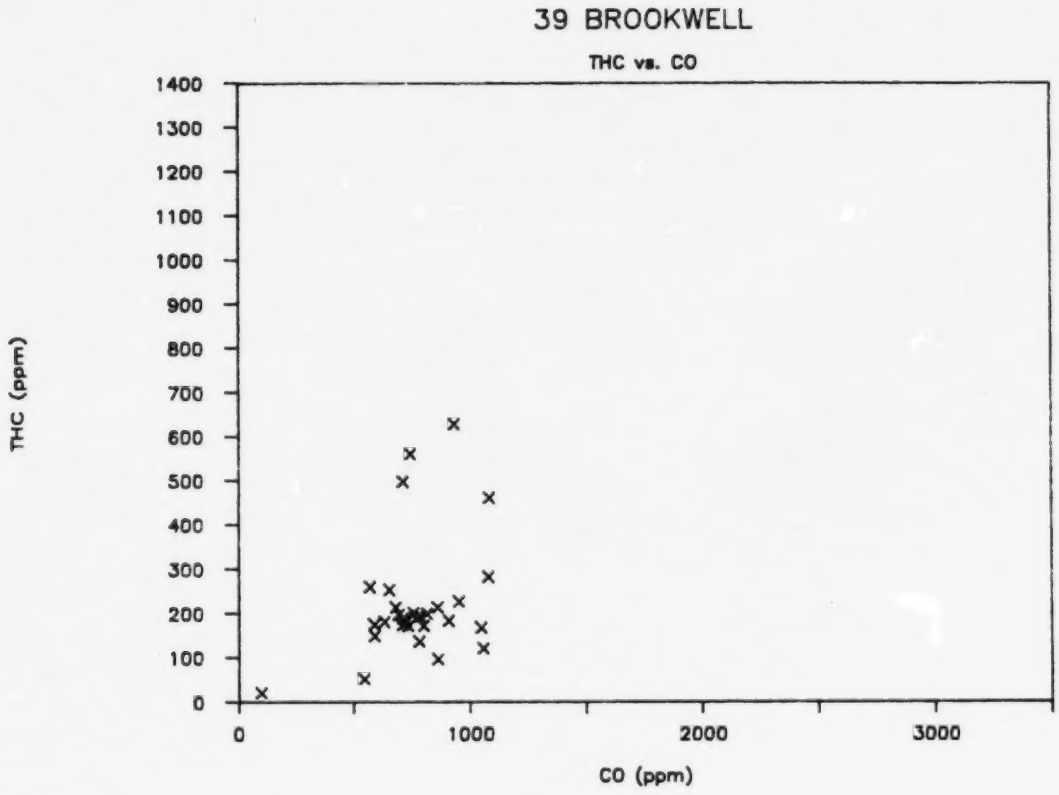


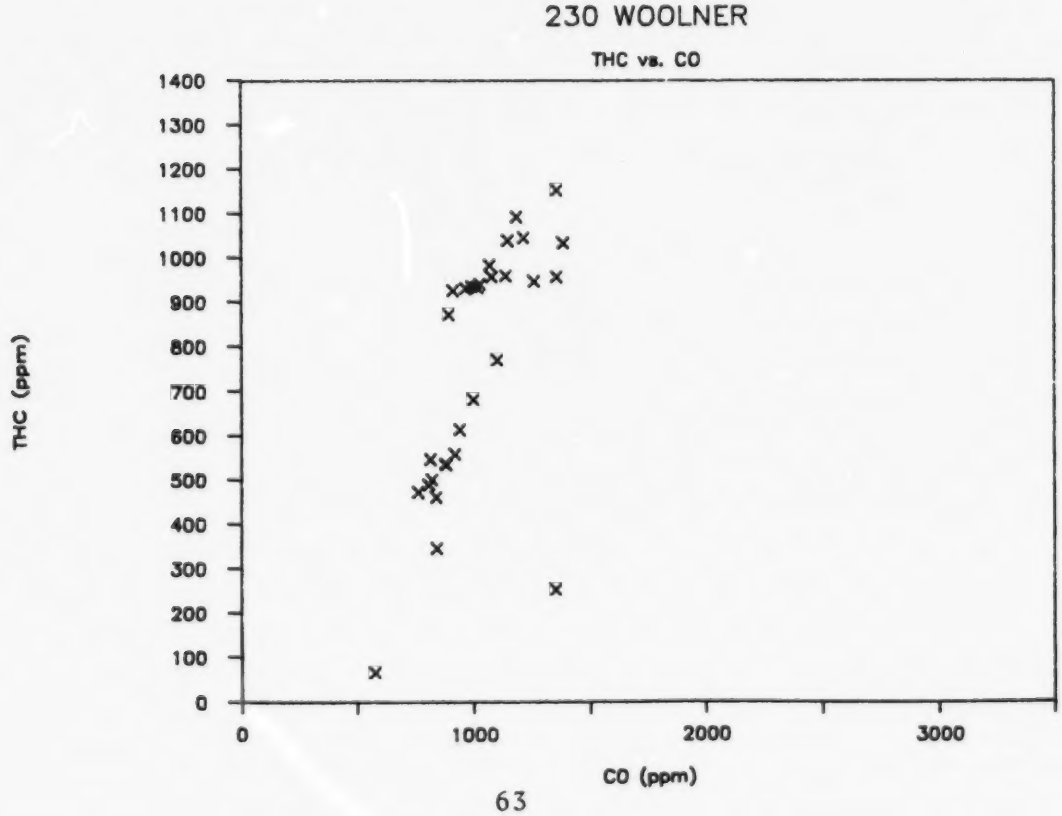

17 LASCELLES
THC vs. CO
THC (ppm)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
CO (ppm)

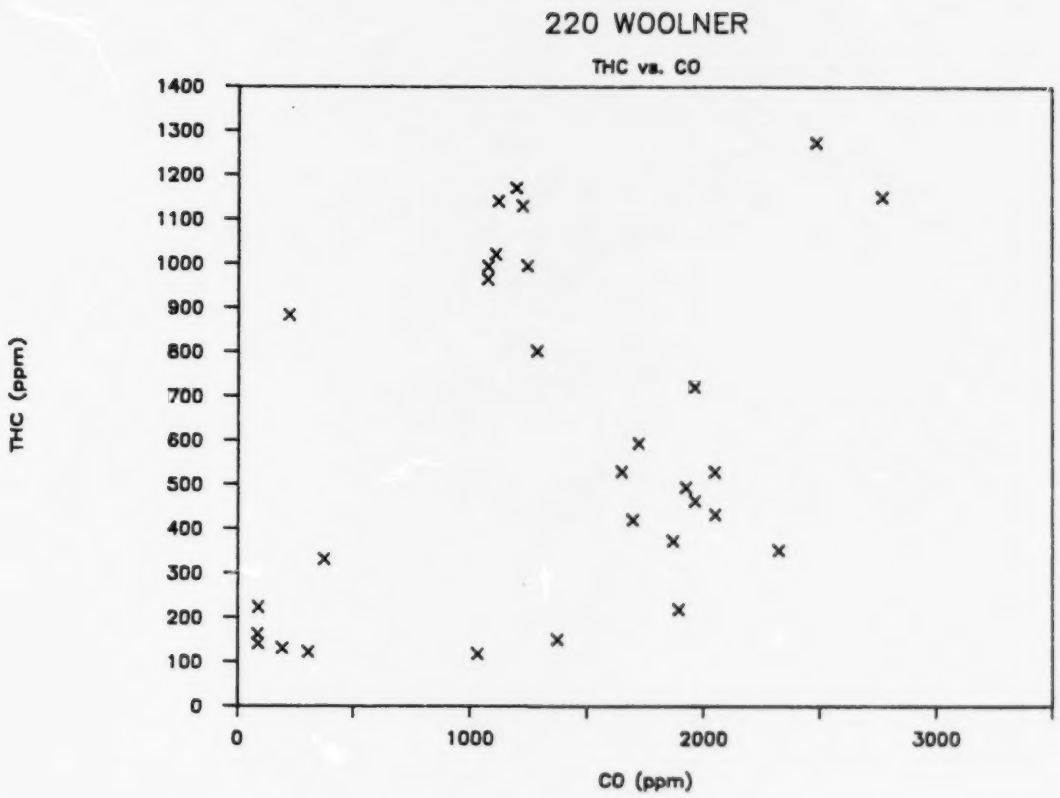

25 LASCELLES
THC vs. CO
THC (ppm)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
CO (ppm)


35 BROOKWELL
THC vs. CO
THC (ppm)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
CO (ppm)


130 COSBURN
THC vs. CO
THC (ppm)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
CO (ppm)


39 BROOKWELL
THC vs. CO
THC (ppm)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
CO (ppm)


230 WOOLNER
THC vs. CO
THC (ppm)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
CO (ppm)


220 WOOLNER
THC vs. CO
THC (ppm)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
1000
2000
3000
CO (ppm)

Appendix E

TEST DATA

Subsequent to First Half Hour

TEST DATA

LOCATION: 6 Mile Post, Toronto
SOURCE: Garbage Incinerator
DATE: 7 July 1986
START TIME: 12:35 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	16.10	3.60	1412	239.3	265	
2	16.42	3.26	1340	213.4	262	
3	16.67	3.16	1134	204.6	260	
4	16.72	3.09	808	218.3	249	
5	16.94	2.69	798	170.6	237	
6	17.34	2.42	890	253.1	228	
7	17.67	2.23	1124	335.3	220	
8	18.15	1.95	1386	386.4	215	
9	18.26	1.92	1349	354.8	209	
10	18.32	1.89	1309	238.5	204	
11	18.36	1.84	1385	255.7	200	
12	18.38	1.75	1317	285.1	192	
13	18.55	1.66	1352	344.6	189	
14	18.75	1.51	1422	429.4	182	
15	19.05	1.23	1419	624.0	175	
Ave.	17.71	2.28	1230	303.5	219	Estd. Feed: 100 kg/hr
High	19.05	3.60	1422	624.0	265	
Low	16.10	1.23	798	170.6	175	

TEST DATA

LOCATION: 8 Mile Post, Toronto
SOURCE: Garbage Incinerator
DATE: 7 July 1986
START TIME: 3:13 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	15.16	4.43	642	401.1	325	
2	15.62	3.99	905	286.3	318	approximately 55.0 kg
3	16.21	3.38	1299	240.9	278	of garbage was fed in
4	16.61	2.77	1350	196.5	270	6 minutes
5	17.51	2.52	1135	255.6	236	
6	17.68	2.21	1397	343.7	210	
7	18.08	1.93	1431	502.2	151	
8	19.40	2.18	1327	671.6	190	
9	15.76	7.49	1565	706.1	418	
10	11.18	8.16	1620	874.4	442	
11	10.38	8.27	1620	1259.6	464	
12	10.87	7.18	584	1275.4	446	
13	12.46	6.32	167	544.7	430	
14	13.16	6.17	227	675.7	431	
15	13.43	5.74	309	670.8	427	
16	13.92	5.48	476	398.1	420	
17	14.38	4.91	699	275.6	405	
18	15.01	4.34	1080	160.4	387	
19	15.52	3.96	1562	215.9	373	
20	15.96	3.61	1620	149.9	357	
21	16.23	3.37	1621	302.4	346	
22	16.58	2.99	1588	376.2	334	
23	16.98	2.70	1620	566.5	320	
24	17.42	2.39	1620	745.7	301	
25	17.83	2.13	1620	954.6	285	
26	18.15	1.96	1620	1109.9	269	
27	18.38	1.83	1620	1173.9	259	
28	18.55	1.73	1620	1126.4	250	
29	18.66	1.68	1603	1164.3	244	
Ave.	15.76	3.99	1226	607.7	331	Ave. Feed: 155.0 kg/hr
High	19.40	8.27	1621	1275.4	464	
Low	10.38	1.68	167	149.9	151	

TEST DATA

LOCATION: 470 Mortimer, Toronto
SOURCE: Garbage Incinerator
DATE: 8 July 1986
START TIME: 12:20 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	19.01	1.18	1213	711.3	115	
2	19.10	1.08	1341	712.0	113	
3	19.15	1.09	1162	681.4	112	
4	19.14	1.05	1321	724.7	109	
5	19.20	0.99	1157	741.4	108	
6	19.23	1.01	1109	749.1	106	
7	19.28	0.93	1240	766.2	103	
8	19.37	0.92	994	733.9	104	
9	19.38	0.85	1152	715.6	102	
10	19.43	0.87	989	663.2	101	
11	19.38	0.94	1004	656.1	100	
12	19.37	0.88	1123	654.8	99	
13	19.42	0.83	960	656.7	98	
14	19.49	0.79	1078	650.2	99	
15	19.54	0.70	954	666.3	99	
16	19.64	0.68	1006	646.4	99	
17	19.65	0.64	1049	640.2	96	
18	19.66	0.67	948	596.3	95	
19	19.70	0.65	1095	601.1	94	
20	19.70	0.64	983	571.9	93	
21	19.71	0.68	1036	593.9	92	
22	19.80	0.62	1081	598.3	91	
23	19.82	0.61	964	118.8	90	
24	20.18	0.01	361	449.8	89	
25	20.57	4.69	11	45.5	85	
26	20.57	8.67	4	28.4	86	
27	20.55	5.21	5	20.5	86	
28	20.55	5.61	5	16.1	87	
Ave.	19.63	1.55	905	550.4	98	
High	20.57	8.67	1341	766.2	115	
Low	19.01	0.01	4	16.1	85	

TEST DATA

LOCATION: 17 Lascelles Blvd, Toronto
SOURCE: Garbage Incinerator
DATE: 9 July 1986
START TIME: 11:44 a.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	20.64	0.09	392	600.9	60	
2	20.60	0.11	382	561.3	64	
3	20.63	0.06	347	543.6	60	
4	20.61	0.12	284	563.0	62	
5	20.56	0.10	247	547.5	61	
6	20.56	0.11	237	535.9	62	
7	20.52	0.09	212	534.2	61	
8	20.58	0.06	263	425.3	60	
9	20.63	0.07	287	496.1	60	
10	20.64	0.02	263	419.9	58	
11	20.66	0.01	270	402.2	58	
12	20.63	N.A.	266	384.6	57	
13	20.66	N.A.	253	343.7	56	
14	20.68	N.A.	272	344.3	55	
15	20.69	N.A.	247	359.3	54	
16	20.69	N.A.	226	261.1	53	
17	20.69	N.A.	245	348.2	52	
Ave.	20.63	0.08	276	451	58	
High	20.69	0.12	392	601	64	
Low	20.52	0.01	212	261.1	52	

TEST DATA

LOCATION: 25 Lascelles Blvd, Toronto
SOURCE: Garbage Incinerator
DATE: 9 July 1986
START TIME: 2:10 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	17.97	1.82	934	728.9	151	
2	17.98	1.76	877	692.9	150	
3	18.09	1.78	865	672.6	152	
4	18.18	1.72	852	644.0	150	
5	18.22	1.72	903	665.6	150	
6	18.13	1.68	889	693.3	149	
7	18.27	1.61	837	640.5	147	
8	18.62	1.46	688	482.7	147	
9	17.20	4.89	1303	460.7	146	
10	13.70	5.22	1242	456.1	149	ashes were stirred
11	14.65	4.32	1829	682.5	207	
12	15.08	4.18	2014	395.7	223	
13	15.25	4.23	1840	392.4	214	
14	15.11	4.28	1812	491.5	217	
15	15.15	3.99	1825	487.8	212	
16	15.45	3.45	1546	391.9	214	
17	16.20	2.84	1343	435.2	215	
18	16.75	2.53	1115	470.0	209	
19	17.09	2.40	1051	507.1	197	
20	17.19	2.33	944	520.0	193	
21	18.17	1.37	870	521.8	189	
22	19.41	1.06	856	457.8	187	
23	19.76	0.93	824	489.4	151	
24	19.90	0.84	759	535.0	136	
25	20.06	0.67	714	523.7	127	
26	20.28	0.57	642	506.1	122	
27	20.34	0.52	616	498.5	110	
28	20.38	0.51	603	493.8	107	
29	20.38	0.49	588	489.2	105	
30	20.40	0.47	561	482.0	104	
Ave.	17.78	2.19	1058	530.3	164	
High	20.40	5.22	2014	728.9	223	
Low	13.70	0.47	561	391.9	104	

TEST DATA

LOCATION: 35 Brookwell Dr, Toronto
SOURCE: Garbage Incinerator
DATE: 10 July 1986
START TIME: 12:02 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	16.78	2.78	941	294.9	305	
2	16.99	2.58	1311	295.9	296	
3	17.26	2.43	1570	323.2	286	
4	17.43	2.29	1713	281.5	283	
5	17.57	2.31	1646	244.1	283	
6	17.64	2.28	1503	257.3	285	
7	17.53	2.46	1357	293.1	297	
8	17.42	2.49	1278	365.1	296	
9	17.34	2.45	950	343.1	306	
10	17.44	2.41	969	312.3	305	
11	17.53	2.26	1024	299.2	308	
12	17.67	2.22	1191	293.2	302	
13	17.70	2.23	1085	270.8	296	
14	17.70	2.28	1123	232.0	298	
15	17.71	2.34	1141	233.6	301	
16	17.68	2.34	1053	285.5	304	
17	17.72	2.42	1100	292.3	305	
18	17.74	2.40	998	276.7	306	
19	17.73	2.43	922	271.6	309	
20	17.60	2.51	827	257.5	311	
21	17.46	2.57	660	254.8	316	
22	17.49	2.47	805	250.9	323	
23	17.61	2.37	862	237.4	324	
24	17.83	2.25	948	151.1	316	
25	17.91	2.20	920	220.4	308	
26	17.97	2.15	889	208.7	305	
27	17.99	2.08	887	215.4	302	
28	18.06	2.08	812	223.9	298	
29	18.12	1.99	808	254.9	295	
30	18.20	1.90	786	247.3	292	
Ave.	17.63	2.33	1069	266.3	302	Ave. Feed: 124.4 kg/hr
High	18.20	2.78	1713	365.1	324	
Low	16.78	1.90	660	151.1	283	

TEST DATA

LOCATION: 35 Brookwell Dr, Toronto
SOURCE: Garbage Incinerator
DATE: 10 July 1986
START TIME: 12:33 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	18.34	1.77	850	264.3	279	
2	18.52	1.61	892	263.8	267	
3	18.71	1.53	926	247.3	257	
4	18.82	1.43	874	246.1	252	
5	18.92	1.40	918	263.3	249	
6	18.98	1.32	893	302.4	244	
7	19.05	1.27	862	334.9	238	
8	19.12	1.21	901	341.5	234	
9	19.23	1.14	895	358.3	229	
10	19.31	1.04	970	361.6	223	
11	19.55	0.95	928	356.0	215	
12	19.59	0.93	917	379.8	210	
13	19.56	0.93	823	417.9	203	
14	19.57	0.89	854	485.3	202	
15	19.70	0.80	782	472.1	200	
16	19.70	0.75	769	475.9	195	
17	19.79	0.68	633	506.7	191	
18	19.83	0.66	643	511.1	188	
19	19.82	0.66	606	480.6	187	
20	19.58	1.17	936	466.1	178	
21	19.13	1.26	944	444.1	179	
22	18.97	1.24	906	454.9	182	ashes were stirred
23	19.18	0.97	897	448.5	207	
24	19.44	0.85	933	562.9	215	
25	19.55	0.75	862	489.8	223	
26	19.64	0.67	821	386.5	212	
27	19.72	0.58	771	63.0	200	
28	19.78	0.58	710	309.6	193	
29	19.85	0.54	695	496.3	189	
30	19.91	0.50	651	492.9	181	
Ave.	19.36	1.00	835	389.4	214	Ave. Feed: 124.4 kg/hr
High	19.91	1.77	970	562.9	279	
Low	18.34	0.50	606	63.0	178	

TEST DATA

LOCATION: 35 Brookwell Dr, Toronto
SOURCE: Garbage Incinerator
DATE: 10 July 1986
START TIME: 1:04 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	19.95	0.49	662	499.8	177	
2	19.95	0.55	655	471.5	175	
3	19.77	0.63	871	435.3	172	
4	19.86	0.48	739	441.4	170	
5	19.99	0.39	630	472.4	166	
6	20.02	0.44	577	478.2	174	
7	20.05	0.48	500	415.6	169	
8	20.12	0.43	451	391.7	165	
9	20.09	0.63	514	355.7	161	
10	19.79	1.16	772	307.2	161	
11	18.53	2.22	678	278.3	154	
12	17.36	3.35	755	266.4	152	additional garbage was
13	15.63	5.10	467	385.8	165	fed in 5 minutes
14	14.60	5.05	318	467.0	230	
15	15.41	3.49	208	358.5	293	
16	16.07	3.89	237	285.5	363	
17	15.81	3.62	281	240.7	390	
18	16.13	3.19	340	225.2	370	
19	16.65	2.54	593	206.5	360	
20	17.48	2.50	944	201.5	379	
21	17.14	2.49	811	188.3	377	
22	17.47	2.19	913	215.6	364	
23	18.03	1.90	1595	182.9	326	
24	18.05	1.93	1420	174.1	340	
25	18.21	1.79	1168	175.2	330	
26	18.40	1.72	1164	374.0	321	
27	18.50	1.73	1061	390.9	318	
28	18.55	1.73	878	369.8	293	
29	18.73	1.71	857	367.3	291	
30	18.80	1.62	803	353.5	284	
Ave.	18.17	1.98	729	332.5	260	Ave. Feed: 124.4 kg/hr
High	20.12	5.10	1595	499.8	390	
Low	14.60	0.39	208	174.1	152	

TEST DATA

LOCATION: 130 Cosburn Ave, Toronto
SOURCE: Garbage Incinerator
DATE: 10 July 1986
START TIME: 7:52 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	14.17	4.89	330	110.1	351	
2	14.54	4.55	325	105.0	352	
3	14.81	4.57	318	103.6	353	
4	14.83	4.40	292	102.7	354	
5	15.06	4.19	299	63.4	353	
6	15.30	4.14	282	81.6	352	
7	15.23	4.02	268	110.7	354	
8	15.58	3.86	288	105.3	356	
9	15.62	3.82	271	107.8	357	
10	15.58	3.79	282	104.5	359	
11	15.67	3.71	287	101.0	360	
12	15.78	3.58	270	99.4	361	
13	15.94	3.66	284	97.1	355	
14	15.88	3.51	269	98.4	360	
15	15.93	3.49	250	96.8	359	
16	16.04	3.46	260	93.6	356	
17	16.06	3.26	251	91.5	356	
18	16.22	3.19	239	89.3	357	
19	16.34	3.01	250	88.3	360	
20	16.48	3.03	232	84.7	357	
21	16.54	3.00	240	81.8	353	
22	16.61	2.76	242	82.6	354	
23	17.38	2.25	192	79.9	354	
24	17.44	2.63	601	143.7	353	
25	16.92	2.58	312	77.0	307	
26	17.53	1.95	157	60.9	268	
27	18.18	1.94	146	56.3	244	
28	18.32	2.02	149	54.3	247	
29	17.90	2.31	159	63.0	269	
30	17.78	2.26	191	63.6	270	
Ave.	16.19	3.33	265	89.9	338	Ave. Feed: 76.0 kg/hr
High	18.32	4.89	601	143.7	361	
Low	14.17	1.94	146	54.3	244	

TEST DATA

LOCATION: 39 Brookwell Dr, Toronto
SOURCE: Garbage Incinerator
DATE: 11 July 1986
START TIME: 12:55 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	16.84	2.23	507	147.9	435	
2	16.94	2.16	542	150.1	430	
3	17.19	2.05	654	131.8	431	
4	17.31	2.01	589	128.2	428	
5	17.40	1.97	579	141.3	420	
6	17.47	1.92	566	160.1	416	
7	17.51	1.91	539	154.1	412	
8	17.55	1.89	543	158.9	408	
9	17.60	1.89	523	159.5	407	
10	17.61	1.92	522	159.4	403	
11	16.85	2.30	506	160.5	402	
12	16.88	2.28	525	161.2	401	
13	16.97	2.19	567	130.4	400	closed damper on feed
14	17.08	2.03	579	116.7	428	door
15	17.47	2.12	592	114.7	436	
16	16.91	2.31	343	117.3	436	
17	17.03	1.66	389	148.0	431	
18	18.04	1.51	560	97.5	426	
19	18.22	1.50	539	143.8	418	closed ash doors
20	18.27	1.51	561	154.4	436	
21	18.32	1.13	532	154.1	401	opened damper and ash
22	19.66	0.54	597	188.7	374	doors
23	20.07	0.46	601	215.4	368	
24	20.14	0.44	584	214.0	365	
25	20.21	0.42	619	233.3	360	afterburner shut off
26	20.22	0.40	585	223.8	257	
27	20.23	0.40	591	223.4	228	
28	20.27	0.38	601	221.7	215	
29	20.28	0.37	577	212.8	207	
30	20.26	0.34	593	206.2	202	
Ave.	18.23	1.48	554	164.3	379	Ave. Feed: 166.0 kg/hr
High	20.28	2.31	654	233.3	436	
Low	16.84	0.34	343	97.5	202	

TEST DATA

LOCATION: 39 Brookwell Dr, Toronto
SOURCE: Garbage Incinerator
DATE: 11 July 1986
START TIME: 12:24 p.m.

TIME (min)	O2 (%)	CO2 (%)	CO (ppm)	THC (ppm)	TEMP (°C)	Observations
1	14.49	5.28	377	230.3	460	
2	13.45	5.63	485	188.8	483	
3	12.94	5.16	408	143.6	507	
4	14.40	4.12	564	179.9	500	
5	14.59	3.86	574	169.4	492	
6	14.87	3.67	624	155.1	485	
7	15.13	3.53	659	142.7	474	
8	15.07	3.84	714	133.6	464	
9	14.96	5.75	692	126.8	460	
10	12.41	5.67	444	142.4	470	additional garbage was
11	13.42	4.37	463	146.4	535	fed in 1 minute
12	14.40	3.91	532	161.3	535	
13	14.89	3.51	592	197.1	501	
14	15.27	3.23	667	190.8	486	
15	15.56	3.06	729	168.1	477	
16	15.74	2.91	727	162.9	470	
17	15.90	2.77	701	160.4	462	
18	16.05	2.70	608	155.6	459	
19	16.15	2.63	579	166.5	456	
20	16.23	2.54	571	175.6	450	
21	16.41	2.50	610	182.9	450	
22	16.47	2.45	705	181.7	446	
23	16.51	2.45	659	175.6	441	
24	16.51	2.38	537	175.3	440	
25	16.58	2.41	586	182.3	439	
26	16.58	2.34	504	176.6	440	
27	16.64	2.33	528	92.2	440	
28	16.71	2.29	557	173.5	437	
29	16.75	2.31	549	164.0	438	
30	16.78	2.28	546	157.7	438	
Ave.	15.40	3.39	583	165.3	468	Ave. Feed: 166.0 kg/hr
High	16.78	5.75	729	230.3	535	
Low	12.41	2.28	377	92.2	437	